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THE

COCCIDÆ OF CEYLON.

BY

E. ERNEST GREEN, F.E.S.

PART II.

WITH THIRTY PLATES.

Smithsonian ...
412190
National Museum

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SUPPLEMENTARY CHAPTER.

Remedial Measures and Insecticides.

In the following pages I have endeavoured to bring together scattered information on the various methods that have been employed in dealing with insect pests of the family *Coccidæ*. Though such treatment may in many cases be found suitable to insect pests of other families, I do not propose to give here a general treatise on insecticides, but to confine myself to measures applicable to the subject of the present work.

Little or no originality can be claimed for the following remarks. They are very largely compiled from the published work of trained entomologists (chiefly American) in different parts of the world. America has long been in the forefront in the practical application of economic entomology.

Remedial measures may be discussed under two main headings: Prevention and Cure. The former, being by far the more important, will be dealt with first :—

Preventive Measures.

Of first importance amongst preventive measures, I would place Quarantine Regulations. It is a fact, repeatedly demonstrated, that imported pests are the most serious. An insect may attract little or no attention in its original home, where it is kept in check by its own natural enemies, a system recognised as 'the Balance of Nature.' But take it away from its home; place it in a congenial climate with an ample supply of suitable food, and it will multiply without the checks that have prevented its increase in its original habitat. The very fact of extensive damage by any insect may of itself almost be accepted as proof of its foreign origin. Looking through the list of the different scale-insects occurring in Ceylon, I find that all the more troublesome species have been previously described from some other country, and are, therefore, presumably imported insects. The home of the 'Lantana bug' (*Orthezia insignis*) is now supposed to be some-

where in S. America ; and there is evidence in favour of the supposition that we owe our 'green coffee bug' (*Lecanium viride*) to Western Africa. *Aspidiotus cydoniæ*, *Chionaspis biclavis*, and *Mytilaspis citricola* were originally described from America. *Aspidiotus camelliæ*, *A. cyanophylli*, *Chionaspis aspidistræ*, and *Dactylopius citri*, are all well known on the continent of Europe. *Aspiodotus aurantii* and *Pulvinaria psidii* have their home in Australasia. Our former coffee pest, the 'brown bug' (*Lecanium coffeæ*) might perhaps be quoted as an exception to this rule, as it was first recorded from Ceylon. But this insect is now considered to be merely a local variety of *Lecanium hemisphæricum*, an insect found all over the world, and whose origin is uncertain. On the other hand, not a single undoubtedly native species has attracted any notice as an insect pest in Ceylon.

We have only to recognise these facts to appreciate the importance of a properly conducted system of quarantine for all imported plants and fruit. Our insular position in Ceylon, with but one main port of entry, gives us a peculiar advantage in carrying out such a system. A single quarantine station, with a single fumigatorium, will be sufficient in our case to deal with the whole importations of the island. It is true that, in spite of quarantine regulations, particular pests have found their way into protected countries. In such cases failure must be attributed to incompleteness of execution. And, though some few pests may have evaded all precautions, how many others must have been refused entry? The records of existing quarantine establishments give long lists of dangerous insects detected on arrival, and destroyed before they have had the chance of obtaining a footing in the new country. I believe it is the custom at most quarantine stations to examine imported plants and fruit, and, if they *appear* to be free from blights, to pass them without treatment. But I maintain that not even the most experienced entomologist could guarantee a plant as absolutely free from insect life. Minute larvæ and eggs may lurk beneath bud-scales, in the axils of leaves, or in unnoticed crevices of the bark. To be really effective, quarantine must be complete. Every live plant and fresh fruit should be subjected to treatment, *whether it appear to be free from disease or not.*

The only sure way of reaching every hidden insect is by fumigation. If properly conducted, there is little danger of permanent injury to the plant. Even though some few delicate plants may be injured, or actually killed by the process, this is a very small

consideration in comparison with the damage that may be effected by a single imported pest. What, for instance, must have been the pecuniary loss to the colony from the ravages of the 'green bug'—a loss that, in all probability, might have been prevented. And compare this loss with the value of all the delicate plants that have ever been imported into Ceylon! But, for such tender plants, it is possible to employ other treatment than is recommended for hardy shrubs and trees.

For wholesale fumigation of plants and fruit there is nothing to equal hydrocyanic acid gas, generated by mixing cyanide of potassium, water, and sulphuric acid in certain proportions. This treatment is cheap and effectual. The gas is of the most deadly nature, and will penetrate every crack and crevice, and do its work thoroughly. The application is quite simple. All that is required is a close-fitting chamber, provided with a flue for the escape of the gas after the operation. The more air-tight the chamber, the more complete will be the work. It should be fitted with racks to receive removable trays, upon which fruit may be spread. The objects to be fumigated are placed into position; the chemicals are mixed in a leaden or earthenware pan and placed on the floor, the door shut, and the room kept closed for from half to three-quarters of an hour. The flue is then opened, and, after a sufficient time (about half an hour) has been allowed for ventilation, the door is unlocked, and the plants, &c, removed. It is not advisable to take the subjected plants directly into the open air if the sun is shining. They should be kept for a few hours under shade, which will greatly lessen any danger of damage.

Mr. C. P. Lounsbury, official Entomologist at Cape Town, has kindly supplied me with full particulars of the work of the Fumigatorium at that place. From his letters and reports I have extracted the following directions and suggestions :—

For each 300 cubic feet of space enclosed (and in proportion for greater and smaller spaces) 1 ounce of 98 per cent. potassium cyanide, 1 ounce of sulphuric acid, and 2 ounces of water will be required to generate gas of sufficient strength to kill the insects. Double this strength, or the same amount of materials to 150 cubic feet enclosed, may be used upon woody plants without danger of seriously injuring them. The greater strength should be employed whenever practicable, as it will ensure the death of the eggs as well as the active insects.

Imported plants are usually in a more or less dormant condi-

tion, which lessens danger of injury. Mr. Lounsbury writes, in his Report of June 1897, 'Injury to the tips of new growth generally results. This injury is in no wise serious, and is quickly outgrown. The operators consider it a favourable indication, as when such injury results it is quite certain that the gas has been present in sufficient strength to destroy all of the insects.'

With respect to fruit, I again quote from Mr. Lounsbury's letter: 'I had lemons and oranges analysed after treatment, and found that after a few hours not more than a trace of the gas remained in the rind. There is much more natural cyanogen in a single seed (so the analyst told me) than what remains in the fruit from fumigation. We have no complaints of any effect on the keeping qualities of the fruit.'

To generate the gas 'the required quantities of cyanide and water are first placed in the generating vessel, the cyanide being broken into small pieces about the size of lump sugar. The operator then adds the acid, pouring it slowly into the vessel to avoid splashing, and immediately withdraws.'

The above treatment is suitable for fruit and hardy plants. Tender garden plants are usually imported in Wardian cases, and may be treated separately. We have—in the 'Wardian case'—an air-tight chamber ready to hand, in which the plants can be fumigated before their removal. After a large series of experiments with various fumigating media, I find that hydrocyanic acid gas remains by far the most efficient insecticide and the least injurious to the plants. But with delicate succulent plants I find it has to be applied rather differently. A more concentrated dose of the gas applied for a shorter period is most satisfactory in its results. In a Wardian case, containing about sixteen cubic feet, I find a dose of $\frac{1}{2}$ ounce cyanide, $\frac{1}{2}$ ounce acid, and 1 ounce water, with an exposure of half an hour, will kill every individual of a colony of Orthezia (the most resistent of all Coccids) without in the least affecting the plants. The treatment should be carried out only after sunset. According to Mr. Lounsbury's tables, these proportions of chemicals should be sufficient for a space of 140 cubic feet with a longer exposure.

The other materials tested were (1) a preparation of concentrated nicotine, sold by the XL-all Company; (2) McDougall's fumigation paper; (3) Jeyes' fluid; (4) naphthaline; and (5) common tobacco leaves. Nos. 1, 3, and 4 were evaporated by means of a small spirit lamp inside the case; Nos. 2 and 5 were lighted and

allowed to smoulder. All these materials, applied in different strengths and for different lengths of time, resulted similarly in more or less complete injury to the plants, and very incomplete destruction of the insects.

If there be no Government quarantine establishment in the general planting interests, importers should safeguard themselves individually by properly disinfecting all foreign plants before distributing them or putting them out in their gardens.

Further directions for the application of the 'gas treatment' will be found in the sections treating of CURATIVE MEASURES. (*See* pp. xxvii—xxxi.)

Perhaps of equal importance as a preventive measure is the maintenance of plants in a vigorous free-growing condition. This is a fact that has been recognised by gardeners for many generations. Anything that interferes with the free flow of sap immediately lays a plant open to attack from its insect enemies. A weakly, hide-bound plant falls an easy prey to every pest. Scale insects in particular, with a few exceptions (and such exceptions chiefly imported series), seem to avoid a free-growing plant, possibly finding the healthy rush of sap too strong for them. Unremitting attention to cultivation will go far towards the prevention of insect pests. Amongst causes predisposing to disease may be mentioned: (1) Careless selection of plants and the retention of weakly seedlings; (2) Insufficient or injudicious drainage; (3) Unsuitable condition of soil, want of tillage, and—perhaps—of fertilisers.

Under the category of remedial measures may be mentioned the use of resistant stock. In the history of nearly every extensive plant disease it has been observed that individual plants—or established varieties of the plant—may show a marked freedom from the disease prevalent upon the less favoured type. By breeding from such individuals, or accidental varieties, a more or less completely resistant stock may be established. This fortunate fact has been frequently used with great success in dealing with fungal diseases. Thus a special variety of the potato plant—proof against the well-known potato disease—has been extensively cultivated. Some varieties of wheat are found to suffer but little from 'wheat rust' (*Puccinia*). We have also examples of certain established strains of cultivated plants that repel particular insect pests. In Europe the vine growers have found an American stock that to a large extent resists the attack of the dreaded *Phylloxera*;

and by grafting on to this hardy stock they have been able to immunise their more delicate and valuable varieties. In Ceylon we have the strongest evidence that certain varieties of the tea plant (especially the Assam indigenous stock) are most markedly free from injury by the so-called 'mosquito blight' (*Helopeltis*). In any serious epidemic that may threaten the profitable cultivation of an economic plant, we should at once be on the look-out for any accidental varieties or strains that may prove resistant to that particular disease. In cases where the hardier stock is not otherwise so profitable as the more delicate variety, by grafting upon it a more valuable scion the latter may sometimes be rendered equally immune.

Curative Measures.

Where preventive measures have failed, as—even with the greatest care—must often happen, recourse must be had to curative measures.

In no single connexion can the old proverb, 'A stitch in time saves nine,' be more aptly applied than in dealing with insect pests. In this case the 'stitch in time' is more likely to save ninety, or nine hundred, or nine thousand!

If a pest is to be eradicated, *immediate* treatment is the most important part of the process.

And the first step towards treatment should, when possible, be the isolation of the infected area. All ordinary work amongst the affected trees should be deferred until after treatment. The young larvæ of scale-insects are very minute and active, and one of the most fertile sources of their distribution is by means of clothing. The rough 'cumblies' used by the estate coolies are particularly well adapted for their transport.

Another important point is that the treatment should be applied *on the spot.* If the infected branches are cut down and carried off to some other part to be burned, they may be shedding the germs of the disease all along the way.

It is difficult to lay down hard-and-fast rules for action, so much depends upon circumstances, *e.g.* the nature of the particular pest, its extent, the nature and value of the plant attacked, &c., &c. But, for the sake of example, we will suppose a case in which three or four tea bushes are found to be infested by some scale-insect that is considered to be a dangerous pest. First dig a fair-sized hole in the midst of the affected clump, and place in it some dry grass and sticks as foundations for a fire. Fill two or

three buckets with one of the insecticide washes described below. Prune back the branches one by one ; immerse each branch completely in the insecticide and throw it into the hole, until nothing but the bare framework of the tree is left. Sweep all fallen leaves and rubbish from beneath the trees into the hole. Next, paint over the bare stems with the same insecticide, using a large paint brush and taking great care to saturate the entire surface down to the ground. Then set fire to the heap of prunings, and cover up the remains with earth. To kill off possible stragglers, the unpruned trees immediately surrounding the affected patch should be thoroughly sprayed with the mixture. If carried out in time, these measures will probably stamp out the pest ; but a careful watch should be kept for any fresh outbreak.

The above treatment is suitable only for such plants as may be cut down without permanent injury. We may now consider the case of some larger tree to which this method would be inapplicable—say an orange or cocoa tree. In this case the gas treatment is the most suitable. The application should be repeated after an interval of about a fortnight, to ensure the death of larvæ subsequently hatched from eggs that may have survived the first operation. Full directions for gas treatment are given below. (*See* pp. xxvii—xxxi.)

In other cases a combination of these two methods might be adopted. If two or three coffee trees should require treatment, all superfluous branches might be pruned, dipped, and burned, and the standing trees fumigated with gas. Modifications of the treatment will be required to suit particular cases.

When a serious pest has once firmly and widely established itself, little hope can be entertained of exterminating it, though much may still be done to keep it in check.

Where trees are large and more or less detached, as in orange groves, and the crop a valuable one, the gas treatment is again the most satisfactory one. But where the cultivation is denser, and the crop not so concentrated, spraying is found to be more practicable.

The choice of the insecticide must be regulated by the nature of the crop. Arsenious compounds cannot be safely applied to food crops—such as fruit and vegetables—during the cropping season. And they can on no account be recommended for such a product as tea, unless employed exclusively after pruning. For, however minute may be the actual amount of active poison

deposited on a single leaf, when we consider that it takes some 400 lbs. of leaf to make sufficient tea to fill a chest, and that about 3000 of the green leaves go to the pound, or 12,000 leaves to a pound of the finished product, it is evident that the amount of poison in a single chest of tea might be considerable. And further, during the processes of packing and transport, it is by no means improbable that this mineral poison—which would dry off in fine powder—might gravitate and become condensed towards the bottom of the chest, with dangerous results to the consumer. The danger may be considered far-fetched ; but I think it should be recognised.

For the above reasons no patent preparations should be employed to any large extent, unless the ingredients are well known. Such mixtures, being designed for general use, may contain several different poisons acting in different ways, either externally by contact, or internally through the alimentary system. The proprietors of patent insecticides not unnaturally object to disclose their formulæ, and put off any questions by asserting that the amount of active poison in the mixture is so very small as to be practically harmless. This may very well be true in most circumstances ; but, as shown above, in other cases the poison might become concentrated into a small portion of the product.

For other reasons compounds that depend upon arsenic or other mineral poisons for their killing properties are of little use against *Coccidæ.* Insects that subsist upon the sap of the plants should be treated with insecticides that kill by contact, such as soap, petroleum, pyrethrum, &c. Arsenic, which adheres to the surface of the plants, is useful only against pests such as caterpillars, grubs, and slugs, that take in solid food. Mr. Maskell puts the matter concisely. He says : 'Whatever damage is done (by scale insects) is effected by the sucking of the juices of the plant through the rostrum (beak) of the insect. It follows from this that applications of any fluid to the tree externally, with the object of poisoning the insects *in their feeding*, would be useless, as their food is drawn from beneath the surface.'*

There are many substances fatal to insect life, but perfectly harmless to the higher animals, that may be safely used. A list of the principal insecticides, with directions for their preparation and application, is appended. (*See* pp. xxxi *et seq.*)

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* *New Zealand Scale Insects*, p. 26.

The most suitable season for spraying is when the young larvæ are hatching. They are then in the most unprotected condition. In temperate climates this season varies with different species, and should be made the subject of careful observation. In tropical countries many species, and those naturally the most pernicious, appear to produce a constant succession of broods throughout the year.

To produce any permanent result, spraying must be very thorough. The success of the treatment depends upon the actual contact of the liquid with the individual insects. Even when the work is done by a trained man, it is practically impossible to secure the destruction of every individual. The difficulty is greatly increased when the work has to be intrusted to natives. In conducting the operation, the position of the insects upon the branches and foliage must be carefully noted, and the nozzle of the machine manipulated accordingly, so as to throw the spray upwards against the backs of the leaves, or downwards on to the upper surface, or horizontally against the stems and branches.

A few words may be said as to the apparatus for spraying. This is not the place to advertise any particular make of machine ; but some general principles may be given to help the would-be purchaser in his choice.

Points to be considered in the selection of a machine should be :—

I. *Adaptability to Transport.*—For ordinary use, where small trees only have to be treated, there is no form so convenient as the knapsack pump. This consists of a metal vessel that rests upon the back, and is supported by straps passing over the shoulders of the operator. The handle of the pump (in the best patterns) comes forward under the left arm, and is worked by the left hand, leaving the right hand free to direct the nozzle which is attached by a flexible rubber tube. The vessel usually contains the pump cylinder, and space for about four gallons of liquid. Where a larger apparatus is required, a barrel pump may be used. In this form the pumping apparatus is fixed in a barrel to which handles are attached, so that the whole apparatus can be carried from place to place by two men. Where the land is flat the barrel, or a metal tank, may be mounted on wheels for transport ; but it should be designed so that the vessel may be dismounted and carried by hand to such places as are inaccessible to the wheeled vehicle. Where the lay of land is suitable, and large trees have

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to be treated, a more powerful apparatus may be mounted on a cart, and drawn by horse or bullock power. In such cases two or more lines of hose and nozzles can be worked from the same tank.

II. *Strength.*—The materials employed in the construction of the machine should be such as are not readily corroded by the mixtures used. Mr. Lounsbury, in his report for the year 1896,* gives the following very practical hints on this subject:—

'Iron is so quickly corroded by many of the common insecticides and fungicides that pumps in which the working parts are of this metal are not desirable. These parts of the pumps should always be made of hard brass. For the sake of economy, the bodies of most pumps are made of iron, but even here the use of brass lends greater durability, and is an advantage which in the end will probably pay for the additional initial cost. Rod-like parts and thin handles of cast iron are objectionable because so easily fractured. Any parts of rubber are damaged by contact with paraffin. Ignorance of this fact has led to the ruin of a large number of Vermorel knapsack pumps, in which a circular rubber disc is used for the propulsion of the liquid. The paraffin causes the rubber to swell, and thus become useless for its purpose.

'Copper is the best metal for tanks in knapsack pumps, and attention should be paid to the thickness of this metal. Thin copper will rapidly wear through. Tanks of sheet iron or tin are soon ruined by contact with liquids containing copper compounds, such as Bordeaux mixture and Paris green, and these preparations are also injuriously affected. But even copper tanks are not suitable for use with all spraying mixtures, since this metal is acted upon by the sulphur in such compounds as "eau grison" and lime-sulphur-salt mixture. In these cases, the sulphur leaves the lime, with which it had united during the process of cooking, and unites with the copper to form copper sulphide. This compound forms in a thin black layer over the copper, which, if it would remain intact, would preserve the metal from further action; but, unfortunately, some of it usually breaks away, exposing fresh surface to the injurious action, and also proving an annoyance by passing through the hose and clogging the nozzle. For these reasons it is best not to use these sulphur mixtures in knapsack pumps.'

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* *Report of the Government Entomologist for the Year* 1896. Cape of Good Hope, pp. 139–140.

III. *Simplicity.*—All the parts of the pump should be readily accessible and removable, so that, should anything go wrong, they may be taken to pieces and cleaned, or damaged parts renewed. The want of these facilities is a serious fault in many machines, the slightest injury necessitating the sending of the whole apparatus to the repairers.

IV. *The Production of a Uniform and Effective Spray.*—The continuity and force of the flow is dependent upon an air chamber in the pump, this feature constituting a 'force-pump.' On this account all hand syringes are almost useless. The nature of the spray is regulated by the form of nozzle employed. The chief object is to break up the liquid into such a fine spray that it will penetrate the thickest foliage in the form of a dense mist and come in contact with every part. For this purpose one of the 'cyclone nozzles' is most admirably adapted. But where it is necessary to throw the liquid to a considerable distance, as, in spraying large trees, a nozzle throwing a coarser spray must be used. It is advisable to have several interchangeable nozzles to suit the different kinds of work. There should always be a detachable cap to the nozzle, so that any obstruction may be quickly and easily removed. Many nozzles are provided with a fine point, held back by a spring, but which, when pushed forward, clears the aperture.

A few further remarks may be quoted from Mr. Lounsbury's report, in which he gives some recommendations for the care of spray pumps. 'Before a spray pump of any kind is put away after use, it should be thoroughly washed and clear water pumped through it ; hot water answers much better than cold if sticky or soapy washes have been used. The working parts should be occasionally oiled, and if the paint on the iron parts becomes worn away it should be renewed. Attention to these details will preserve the pump for a long period, while, if they are neglected, the pump may never save its initial cost.'

Before quitting the subject of general remedial measures and entering upon detailed descriptions of particular processes, something should be said upon the important question of the introduction of 'natural enemies' of the *Coccidæ.* The same circumstances that make an imported pest so exceptionally dangerous act in our favour in the importation of beneficial insects. Just as the absence of its established natural enemies enables an insect pest to multiply without hindrance, so the

introduction of a beneficial insect without its own natural checks will also permit of its rapid increase as long as an ample supply of congenial food is obtainable. When the food supply begins to fail, which means when the pest has been mastered by its imported enemies, then they will both decline together. There need be little fear that, when the food supply has been exhausted, the imported insect will itself become a pest. A predatory insect, by which is understood one that preys upon other insects or animals, will seldom, if ever, alter its diet and become a vegetarian.

It is noticeable that an insect seldom assumes any importance in its original home, unless through some accidental or artificial interference with the balance of nature in that part. (For instance, it has been asserted that the widespread destruction of moles in England has resulted in a marked increase of damage to pasture land from the grubs of the 'cockchafer' beetles and 'crane-flies,' upon which the moles fed.) Consequently, if we are to obtain any benefit from the use of natural agents, we must endeavour to reproduce the conditions prevailing in the country where the insect in question is known to occur, though without attracting notice as a pest. Or, if the original home of the injurious insect is unknown, we may reasonably hope for good results from the introduction of an insect that is found to prey upon some allied pest in another country.

The most important natural enemies of the scale insects, or, at least, those that have attracted most attention, belong to a family of small beetles popularly known as 'lady-birds.' The complete success attending the introduction of an Australian lady bird (*Vedalia cardinalis*) into California, where it cleared the orange orchards of the destructive 'Fluted-scale' (*Icerya purchasi*) has led to numerous other experiments of a similar kind. These experiments have not always been successful. There must, of necessity, be many failures. We are still only in the experimental stage of the work. Even when the beneficial insect has been successfully established in a country, it is by no means certain that it will thrive. There may be climatic or other conditions against it. In that case, all we can do is to try another insect. Occasional, or even repeated, failures should not discourage the repetition of the attempt. The value of a single success will far outweigh the cost of many failures. In the course of such experiments the causes of failure will in time be ascertained, and improved methods be employed. The freezing method recommended by Mr. Kœbele

seems to be rather an uncertain one, and has led to many disappointments. I am inclined to hope for more satisfactory results from the employment of 'Wardian cases,' as suggested to me by Mr. Lounsbury. In these the insects will remain active and be supplied with food. There are certain obvious dangers connected with this method, such as the possible introduction of the insect pest upon which the 'lady-birds' have been supported during the voyage. For this reason the business should be conducted under the supervision of trained entomologists only. In choosing the food supply, an insect that already occurs in the country to which the lady-birds are consigned should, if possible, be selected.* But, under any circumstances, the imported beetles should not be liberated immediately, but should be transferred to fresh breeding cages and supplied with local food, and the cage in which they arrived should at once be thoroughly disinfected. In sending stocks by Wardian case, the larvæ of the beetles may with advantage be included. These will complete their transformations during transit, and are more likely to survive the voyage than the adult insects.

There are other natural enemies of the Coccidæ that may some day be advantageously employed in the same way. Amongst the two-winged flies (*Diptera*) we find the *Lestophonus iceryæ*, which attacks the 'Fluted-scale.' Nearly every species of scale insect is subject to minute internal parasites belonging to the wasp family (*Hymenoptera*). The family *Neuroptera* supplies the 'Lace-wing flies,' the larvæ of which are known as 'Aphis-lions,' from the voracious way in which they feed upon Aphides and scale insects. Even the butterflies and moths (*Lepidoptera*) provide a few coccid-eating species, such as the caterpillars of the butterfly *Spalgis epius* and of several moths of the genus *Eublemma*. The 'lady-birds' are included in the family *Coleoptera*.

Besides natural enemies belonging to the animal kingdom, scale insects are subject to diseases belonging to the vegetable world. There are several parasitic fungi that render great assistance in reducing the numbers of our Coccid pests. In Ceylon, during the wetter months of the year, the 'green bug' (*Lecanium viride*) dies off to a large extent, attacked by a greyish mould

* In a recent consignment of 'lady-birds' received from the Cape of Good Hope, the cochineal insect (*Coccus cacti*) was very judiciously chosen for the purpose. This insect is practically confined to the 'Prickly Pear' cactus, and is therefore not liable to become a pest.

which, after killing the insect, spreads outwards as a delicate fringe of interlacing whitish threads. A bright orange-coloured fungus (Septoria ? sp.) is useful in checking the increase of *Fiorinia fioriniæ* and *Chionaspis biclavis* on the tea plant, and *Aspidiotus aurantii* on orange trees. A very similar fungus (*Sphærostilbe coccophila*) that attacks *Aspidiotus perniciosus* in Florida (U.S.A.) has been the subject of some very interesting experiments to test the possibility of communicating the disease to previously healthy colonies of the insect. Dr. L. O. Howard gives the following particulars of the experiment:*—

'An interesting and important development of the past two seasons' work has been the identification and study of the parasitic fungus, *Sphærostilbe coccophila.* Professor Rolfs, of the Florida Station, has devoted a bulletin largely to the consideration of this fungus, which, as previously stated, seems to be prevalent throughout the Southern States. He has shown experimentally that the fungus may be transferred to trees affected with San José scale, and the disease produced among the scales. His process was to inoculate acid bread with pure cultures of the fungus, and three weeks later the application was made in the following way:—A piece of the bread about an inch square was placed in cold water, and shaken until the bread was broken up and the spores distributed in the water. This water was then applied to the scaly tree by means of a sponge or cloth, or sprayed on. The applications were made in Midsummer of 1896, and observations were made as to the results late in February, 1897. Four of his experiments resulted successfully, and three unsuccessfully, while in the eighth experiment the result was doubtful on account of the tree having died between the times of treatment and inspection. Twigs from Florida containing Sans José scales, infested by the fungus, were sent to Mr. Horace Roberts, at Fellowship, N.J., about the middle of June. On September 25th Dr. Smith found the fungus upon almost, if not quite, all of the trees on which twigs had been tied. A number of instances have come to our observation of the death of the scale in a wholesale manner from the spontaneous work of this disease, or from some other cause. For example, we received scale-infested cuttings in January, 1897, from an orchard which was said to have been freed from scales by this fungus disease. Careful

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* *Bulletin*, No. 12. (New Series.) U.S. Department of Agriculture (Division of Entomology).

examination showed that upon one cutting, out of 183 scales, but four were living; on a second cutting, out of 723, but two were living; on a third cutting, out of 579, but twenty-eight were living, giving thirty-four living scales out of 1485—a mortality rate of 97·7.'

I have, myself, repeatedly succeeded in disseminating the disease affecting *Lecanium viride* by tying branches with diseased insects on to trees on which the bug had hitherto remained quite healthy.

There are several methods by which spores of these parasitic fungi may be disseminated. As in the last-mentioned experiment, they may sometimes be communicated by merely transferring affected branches to the neighbourhood of the healthy insects. In such cases the spores are carried by the wind to their destination. But in some of these fungi the spores are gelatinous and agglutinated, in which case the wind would fail to disperse them. Fungi of this kind may be crushed up in water and used as a spray; or artificial cultures may be made and mixed with water, to be used in the same way. In the ordinary course of nature these gelatinous spores are probably carried from tree to tree on the feet of birds.

General List of Substances and Processes Employed in the Treatment of Scale Insects.

The Gas Treatment.

Hydrocyanic acid gas is the material employed in this process It is generated by the admixture of cyanide of potassium, sulphuric acid and water. For the details of treatment I cannot do better than quote *in extenso* from the admirable paper on 'Gas Treatment for Scale Insects,' compiled by Mr. C. P. Lounsbury from his personal experience as Government Entomologist at the Cape of Good Hope. The process described was principally employed against *Aspidiotus aurantii*—an insect that appears to be distinctly on the increase in Ceylon. I may add that I have followed Mr. Lounsbury's directions in my own experiments with most satisfactory results.

'*Generation of the Gas.*—Hydrocyanic acid gas is generated by

the action of sulphuric acid on potassium cyanide in the presence of water. The required quantities of the cyanide and water are first placed in the generating vessel, the cyanide being broken into small pieces not above the size of lump sugar. The tree is then covered with the tent or sheet and the vessel slipped under almost to the base of the tree; reaching in, the operator then adds the acid, pouring it slowly into the vessel so as to avoid its splashing and thus burning his hand or the cloth. He immediately withdraws and the men shovel a little soil on the edges of the cloth all around, to more thoroughly prevent the escape of the gas.

'The rapidity of the evolution of the gas depends largely upon the size of the pieces of cyanide. If these are like powder, the reaction is violent and immediate; but, if in lumps, the reaction takes place more slowly and continues for a minute or longer. The slow reaction is desired, partly because less injury results to the foliage immediately above the vessel. But the lumps must not be too large, for then the reaction is liable to be imperfect owing to a black coating (carbon?) forming over the lumps and preventing further decomposition by the acid. The water should not be added too soon or part of the cyanide becomes dissolved and gives a violent reaction. The residue which remains in the dishes is buried; and the dishes are washed in clean water before being again used.

'*Time necessary for Treatment.*—The cover is left over the tree for thirty minutes in the case of small trees, and forty-five in the case of those over twelve feet in height. At the expiration of this period the generating vessel is removed, and the residue buried in the soil.

'A number of trees are fumigated together, the endeavour being to treat as many at a time as can be covered and uncovered duried the period of exposure. In this way the men are kept continuously busy, the time for the removal of the first tent arriving by the time that the last tree is covered.

'*Absence of Sunlight necessary.*—The originators of the fumigation process observed that the gas was most efficacious, and that less injury resulted to the foliage when the operations were performed at night than when they were carried on in sunlight. It is said that chemical changes are produced in the gas by the action of sunlight, and that the resulting gases are more injurious to the plant life and less to animal than hydrocyanic acid gas. Whether or not these theories are correct is of small practical importance,

for the foliage of a tree will suffer serious injury if the tree is left covered with an air-tight oiled tent for half an hour in sunlight, without the gas being present. Having ascertained this fact by experience, the foreman in charge of the Board's outfit refrained from covering trees until the sun had sunk from sight on any but cool, dull days. The great majority of the trees treated have been fumigated after sunset. The ideal night for fumigating is quiet, cool, and moonlight, and without dew.'

It is evident, from the above, that the period available for this process is somewhat limited. However, when only a few trees have to be treated, the hour immediately preceding nightfall will be ample for the purpose. I have personally found no ill effects following the operation when performed on dull, cloudy days, when the sun is entirely obscured.

Although hydrocyanic acid gas will certainly kill every insect —and even their eggs—if used in sufficient strength and for a sufficient length of time, both the necessary strength and time will be found to vary with different species of insects, and must be made the subject of careful experiment. I find that *Orthegia insignis* is a very difficult insect to kill, and requires a double strength of gas, continued for fully three-quarters of an hour.

Mr. D. W. Coquillet, one of the first to employ this process, gives the following directions for making an air-tight tent: *—'The material commonly used in the construction of the tent is what is known as blue or brown drilling. A few persons have used ducking instead of drilling, but this is much inferior to the latter; in the ducking the threads extend only lengthwise and crosswise, whereas in the drilling they also extend diagonally—this belonging to the class of goods to which our merchants apply the term "twilled"—and for this reason the drilling is both stronger and closer in texture than the ducking.

'After the tent is sewed up it is given a coat of black paint, as it has been ascertained that tents treated in this manner last longer than those which have been simply oiled with linseed oil. Some persons mix a small quantity of soap-suds with the paint in order to render the latter more pliable when dry, and therefore less liable to crack. Instead of thus painting the tent some persons simply give it a coating of size. Sometimes a small quantity of whiting

* U.S. Department of Agriculture (Division of Entomology). *Bulletin*, No. 23.

or chalk is added to this sizing, with or without the addition of lampblack. A few make use of the mucilaginous juice of the common cactus (*Opuntia Engelmanni*) for this purpose. To obtain this, the cactus leaves or stems are cut or broken up into pieces, thrown into a barrel, and covered with water, after which they are allowed to soak for three or four days. The liquid portion is then drawn off, and is ready for use without further preparation. Tents which I saw that had been prepared with this substance were to all appearances as air-tight and pliable as when prepared in any other manner.'

For the oiling, Mr. Lounsbury recommends a mixture of four parts boiled linseed oil to one part turpentine. The cloth should be first well wetted with water, and the mixture spread lightly over the surface with a brush. A thin coating is found to be sufficient. Mr. Lounsbury has since informed me that he now uses, with completely satisfactory results, tents made of cloth merely shrunk in water, without any subsequent oiling. Such tents are, of course, much lighter and more easy to manipulate.

Mr. Coquillet gives the annexed table, showing the quantities of chemicals required for different-sized trees.

Height of tree.	Diameter of tree top.	Water.	Sulphuric acid.	Potassium cyanide.
Feet.	Feet.	Fluid ozs.	Fluid ozs.	ozs.
6	4	⅔	⅓	⅓
8	6	2	1	1
10	8	4½	2¼	2¼
12	10	8	4	4
12	14	16	8	8
14	10	10	5	5
14	14	19	9½	9½
16	12	16	8	8
16	16	29	14½	14½
18	14	26	13	13
20	16	36	18	18
22	18	52	26	26
24	20	66	33	33

Mr. Lounsbury, after practical experience at the Cape, publishes the following figures, from which it appears that he found smaller quantities sufficient. This is, doubtless, due to difference

in purity of the chemicals. Mr. Lounsbury was working with cyanide of 98 to 100 per cent. purity, while Mr. Coquillet was using cyanide of only 33 to 58 per cent. It is therefore important to know the exact amount of pure potassium cyanide in the particular brand employed.

Height.	Diameter.	Water.	Acid.	Cyanide.	Space enclosed.
Feet.	Feet.	Fluid ozs.	Fluid ozs.	ozs.	Cubic feet.
4	3	¼	⅛	⅛	25
6	4	½	¼	¼	65
8	5	1	½	½	140
8	6	1½	¾	¾	200
10	6	2	1	1	255
10	8	3	1½	1½	435
12	8	3½	1¾	1¾	535
12	10	5½	2¾	2¾	815
14	8	4½	2¼	2¼	635
14	10	6½	3¼	3¼	970
14	12	9	4½	4½	1355
16	10	7½	3¾	3¾	1130
16	12	10½	5¼	5¼	1585
16	14	14	7	7	2105
18	12	12	6	6	1810
18	14	16	8	8	2415
18	16	20	10	10	3085
20	14	18	9	9	2720
20	16	23	11½	11½	3485
20	18	29	14½	14½	4325
22	18	32	16	16	4835
22	20	39	19½	19½	5865
24	20	43	21½	21½	6500

The gas treatment has been largely used in combating scale insects (particularly *Aspidiotus aurantii*) on orange trees. It will be found the most effectual method for exterminating *Orthezia insignis*, or any other insect, upon individual trees.

Soap and Soapy Emulsions.

Soap by itself has considerable insecticidal properties. In fact, in many popular mixtures, it is extremely probable that the soap is the most efficacious ingredient. It acts by asphixiation, forming an impervious film over the breathing pores of the insects.

Whale-oil soaps are found to be the best for the purpose. In *Insect Life*, vol. vii. p. 369, the following conclusions are drawn from numerous experiments upon trees infested with the San José scale (*Aspidiotus perniciosus*) in America:—'Soap washes, particularly of whale-oil soap, have yielded the most satisfactory results; and at the rate of two pounds to the gallon, under the conditions of thorough drenching of the entire plant, with five or six days of subsequent fair weather, will destroy all the scales, whether applied in fall or in spring. The results with soap in less strength indicate that under the most favourable conditions the same result may be reached with mixtures containing only a pound and a half or more of soap. The action of the soap at the rate of one pound or more to the gallon, applied in the fall, is generally to prevent blooming and fruiting the following spring, but the vigour and healthfulness of the tree are greatly increased. Applied in spring at the time of blooming, it does not injure the plant nor affect the setting of the fruit to any material extent in the case of the peach, and not at all in the case of the apple.

'The experiments, as a whole, indicate the vastly superior merit of the soap wash and its fall application. The greater vigour of the plant resulting from the fall treatment more than offsets the possible failing of bloom. Owing to the impossibility of controlling weather conditions, and the practical difficulty of wetting every part of the plant, one spraying cannot often be relied on to accomplish the death of all the scales, but two conscientious drenchings may be expected to accomplish this result. These may be (1) at the time of, or shortly after, the falling of the foliage in autumn, and (2) just before blooming in spring.'

Other soaps (hard laundry soap) are efficacious, but not to the same degree.

In another of the American reports* is an instructive paper on insecticide soaps, by Mr. C. L. Marlatt, from which I take the liberty of quoting largely:—'The decided insecticide value of the so-called whale-oil (more properly fish oil) soaps, against scale insects particularly, has been fully demonstrated in the last few years in the work against the San José scale, and has fully substantiated Professor Cornstock's early recommendation of this means of controlling scale-insect pests. The merit of these soaps

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* *Bulletin*, No. 6 (New Series), U.S. Department of Agriculture (Division of Entomology).

is not only in their effectiveness as insect-destroyers, but from their being entirely without injurious effect on the treated plant. In this respect they are perfectly safe in the hands of any person, in contradistinction to all oily washes, which are very liable to be injurious in greater or less degree, although the injury may be insignificant, or perhaps not apparent immediately, or during the first season.' . . . . 'The use of soaps is attended with certain difficulties.' . . . . 'To be satisfactory for insecticide use it must, when dissolved at the desired rate, say two pounds to the gallon of water, remain a liquid capable of being sprayed with an ordinary nozzle at an ordinary temperature. This may be determined by a very simple test, and one which should be invariably given any soap before it is accepted for spraying operations. It consists in simply dissolving a small quantity of the soap at the desired rate, and allowing it to cool.'

Many soaps solidify or become gelatinous and tenacious on cooling. These are useless for spraying purposes. The common country soap of Ceylon has this defect. I have experimented in a small way with soap mixtures; but it is difficult to obtain here a brand that combines suitability with cheapness. Such a brand is a great desideratum. I find that one of the most useful properties of the soap mixtures is to prevent the escape of the young larvæ by blocking up the natural exits, and on this account the treatment is to be very strongly recommended.

Kerosene Emulsion.—Soap is often combined with other ingredients. Of these kerosene emulsion is the best known and most widely used. As its efficacy and its effect upon plant life very greatly depend upon the preparation of the mixture, great care should be taken to accurately follow the directions. The formula in general use is:—

Soap	½ lb.
Kerosene	2 gals.
Soft water	1 gal.

'Dissolve the soap in the water heated to boiling, then add the kerosene (to the hot mixture), and churn it until a creamy fluid results, which thickens on cooling, and adheres to glass without separating into oily particles.'

Whale-oil soaps are preferable, but any kind may be used. I have personally made a very successful emulsion, employing the common country soap, which seems to be particularly well adapted to retaining the oil in an intimate mixture, and which, in this

combination, loses its own objectionable properties. The most important part of the process is the *churning*. This must be most thoroughly carried out. It can be satisfactorily managed by repeatedly drawing up and expelling the mixture through an ordinary garden syringe or a force-pump. A more lengthy method is to stir the mixture vigorously with a whisk of twigs. The liquid should be boiling hot during emulsification, and then, if kept in a cool place, it is said to last for a year or more without separating. If insufficiently churned, the mixture will afterwards become separated, and the oil collect at the top. A properly compounded emulsion will mix with water in any proportions.

For use against scale insects a strength of one part emulsion to ten of water is found to be effective. As in all preparations of which petroleum is an ingredient, it can be more safely used on cloudy days. When used in hot sunshine, it is liable to burn the foliage and injure the tender shoots of the plant, but the danger of injuring is much less with a properly prepared emulsion than with mechanical mixtures of kerosene and water. Mr. Marlatt, in some 'Notes on Insecticides,'* gives the following particulars of experiments which show that kerosene emulsion can be be used of considerable strength without causing appreciable injury to the plants. But it cannot be recommended for general use at a greater strength than mentioned above. Mr. Marlatt writes: 'About the 1st May, when the foliage was in the vigour of its early growth, a number of plants—peach, Japan quince, elm, pine, and strawberry—were treated with the following strengths of kerosene and whale-oil soap emulsions, made after the standard formula: Diluted (1) with 2 parts of water, (2) 4 parts of water, (3) 9 parts of water, and (4) 14 parts of water, or the emulsion at $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{10}$, and $\frac{1}{15}$ strength. The application was very thorough, and the limbs and twigs were thoroughly wetted by immersion in the insecticide. The treatment was made on a very bright, warm day, in the early afternoon. No rain occurred for four days, after which there were heavy rains. No injury whatever developed in the case of the pine, strawberry, and elm with any of the strengths used. With peach the injury was trifling, a very small percentage, perhaps one or two per cent, of the leaves turned yellow and fell to the ground, but I am inclined to believe that this was merely the normal spring shedding of the leaves, which is seen in nearly all plants.

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* *Insect Life*, vol. vii. p. 116.

In the case of the Japan quince, however, with the two stronger mixtures, namely, those with one-third and one-fifth kerosene emulsion, a few yellow spots appeared on the leaves, and later, upon handling the limbs treated with the strongest mixture, about one-fourth of the leaves were found to fall off readily. These leaves, while looking comparatively healthy and green, had evidently been injured more than their surface appearance indicated. With No. 2 this peculiarity was almost unnoticeable, and with Nos. 3 and 4 no injury whatever was shown, nor did any further injury manifest itself throughout the season in the case of any of the plants treated. These experiments would indicate that the kerosene emulsion can be applied in much stronger dilution to tender foliage of growing plants than has hitherto been supposed.'

On the other hand, there are well-authenticated reports of plants seriously injured, or even killed, by the use of too strong a mixture, and the application during sunny weather is attended with danger. In my own experience I have found the tender shoots on a recently pruned tea bush to be completely killed back by a comparatively weak mixture applied during sunny weather.

When the foliage of a plant is attacked, the applications should be made by means of a spraying machine. In the case of pruned trees, when the pest affects the bark only, the liquid can be applied with a brush or a piece of rag to the stems and branches. Care must be taken that the liquid is not used in sufficient quantities to run down and saturate the roots of the plant, or grave injury may result. When employed with proper precautions, there is no doubt that we have in kerosene emulsion a very valuable remedy against scale and other insect pests.

Milk may be substituted for the soap in the manufacture of kerosene emulsion. The formula given by Hubbard is:—'One part milk (sour milk is said to be as suitable as fresh for the purpose), to two parts kerosene. Heat the milk nearly to boiling point and mix with the kerosene. Churn the mixture violently until a thick creamy fluid is obtained. For use against scale insects dilute with nine or ten times the quantity of water.' I have been unable to find any definite statements as to the comparative effectiveness of the milk and soap emulsions. It is possibly a question of cost. In some countries a gallon of milk may be cheaper than half a pound of soap; but in most places it is probable that the balance of advantage will be on the other side. The active insecticidal properties of soap itself must surely be an additional advantage.

Kerosene.—Much diversity of opinion exists as to the use of pure kerosene or a mechanical mixture of kerosene and water. It is undoubtedly effective as an insecticide.

But in too many cases it is equally fatal to plant life. Reports are very conflicting. In some cases spraying with the undiluted oil has been unattended by any injury to the tree, while particularly successful in killing the scale. In other cases even large trees have succumbed under the treatment. One cause of injury is said to be the collection of oil at the base of the tree, the roots being apparently much more sensitive to injury than the exposed parts. As a precaution, earth should be banked up round the base of the tree, and only sufficient oil should be used to moisten the surface of the foliage and bark without any surplus to run down the stem.

Mixtures of kerosene and water have been largely employed in America, and elaborate machines devised for ensuring the proper mixture of the two ingredients. But under any circumstances their effectiveness does not compare favourably with a properly compounded emulsion.

Referring again to one of Mr. Marlatt's reports,* I find it stated that 'kerosene mixed with water is not nearly so powerful an insecticide as the kerosene soap emulsion. It does not remain nearly so long on the plant, and is not nearly so effective an insecticide at the same strength of oil. The heavier soap or milk emulsions kill more effectively, which is, perhaps, explained by the heavier liquid actually bringing more oil in contact with the insect, and also by its greater permanency.' Taking everything into consideration, neither kerosene, nor mixtures of the oil and water, can be recommended for general use—at any rate in the Tropics.

Resin washes.—These are used extensively in California to remove scale insects from fruit trees. The formula (taken from *Bulletin*, No. 9 of the U.S. Department of Agriculture) is as follows:—'The summer wash usually contains twenty pounds of resin, five pounds of crude caustic soda (seventy-eight per cent.), or three and a half pounds of the ninety-eight per cent., and two and a half pints of fish oil. The winter wash contains thirty pounds of resin, nine pounds of crude soda, and four and a half pints of oil. The ingredients are boiled in about twenty gallons of water for two

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* *Bulletin*, No. 9 (New Series), U.S. Department of Agriculture (Division of Entomology).

or three hours, hot water being occasionally added until fifty gallons of solution are made. This, for both formulæ, is diluted to one hundred gallons before application to trees. Greater efficiency is believed to come from long boiling of the mixture, and it is preferably applied hot. It is used on deciduous trees for the black and San José scales, and on citrus trees for the red and black scales; but the dense foliage of the latter renders thorough spraying difficult except for young trees, and fumigation is much preferred. An improperly made resin wash is also apt to spot the fruit of the orange.' I have no personal experience of either this or the following insecticide.

Lime Salt and Sulphur Wash.—This has been employed against the San José scale in America. Though undoubtedly effective in some parts of the country, it appears to have completely failed in others. Mr. Marlatt writes :—'Our experience with this wash in the East (Eastern States) had thrown doubt on its real efficiency as an insecticide, and it has been clearly demonstrated that under the climatic conditions east of the Alleghanies it is almost valueless. In California, however, after a careful study of the facts in the field, I am compelled to admit that the demonstration of its usefulness against the San José scale is complete, and the benefit of its application to orchards is most manifest. In the vicinity of Pomona, California, unsprayed orchards were badly infested with San José scale, while in adjoining sprayed orchards the scale was entirely killed, and the trees were rapidly recovering and showing vigorous and healthy new growth. In contiguous orchards also of the same kinds of trees, similarly treated so far as cultivation is concerned, the trees which had been subjected to yearly spraying were at least one-third larger than untreated trees. This wash is of value also as a fungicide, protecting stone fruits from leaf fungi, and is also a protection against birds, the common California linnet doing great damage to buds in January and February. The wash is almost invariably made and applied by contractors, and costs about five cents per gallon applied to the trees. It is a winter application, being applied in January and February.

'Along the coast region and in Northern California, where moister conditions prevail, this wash is very much less successful, bearing out somewhat the experience of the East, and doubtless explained by the similarity of climate in the districts mentioned with that of the Atlantic seaboard.

'In making this wash the chief consideration seems to be

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prolonged boiling. The wash itself is practically a sulphide of lime, with much free lime and salt carried with it. Prolonged boiling will result in taking up temporarily additional sulphur, and will perhaps add to its caustic properties if it is applied very hot; on cooling, however, it reverts to the simpler tri- or bi-sulphite of lime. The proportions of the ingredients and the method of combining them vary slightly in different sections. The following is the ordinary formula: Unslaked lime, 40 pounds; sulphur, 20 pounds; salt, 15 pounds. One-fourth of the lime is first slaked and boiled with sulphur in 20 gallons of water for two or three hours; the remainder of the lime is slaked and, together with the salt, is added to the hot mixture, and the whole boiled for half an hour or an hour longer. Water is then added to make 60 gallons of wash. This wash is applied practically every year, or as often as the San José scale manifests itself in any numbers.'

Carbolic Acid.—Crude carbolic, phenol, Jeyes' fluid, and similar compounds, all have insecticidal properties. Carbolic acid itself has been found inefficient except when applied in such strength as to seriously damage the plants. I find that phenol and Jeyes' fluid (which appears to be much the same thing) are effective against *Orthezia*, 'mealy bugs,' and most species of *Lecanium*. A mixture containing 1 part of Jeyes' fluid to 20 of water, applied to a Thunbergia bush attacked by *Orthezia*, was fatal to more than 90 per cent. of the insects, but resulted in the death of the terminal buds of the plant. It had no bad effect upon the more mature leaves and shoots. The application did not, however, prevent the subsequent hatching of the eggs in the ovisacs of the dead insects. Weaker solutions were proportionately less effective.

In a 'Report on the Green Scale Bug, *Lecanium viride*,' published in 1886, I have mentioned that phenol applied to the ground around the roots of the coffee tree appeared to cause the disappearance of the scale. But subsequent experiments have not corroborated this result, and I must suppose that the apparent benefit in the earlier experiment was due to some other cause. Single experiments are practically useless. They are liable to be vitiated by adventitious circumstances. Until similar results have been obtained from repeated experiments, no confidence can be placed in any treatment.

Tobacco Water.—'Steep 5 lbs. of refuse tobacco (stems, &c.) in 3 gallons of water for three hours. Strain the decoction and add sufficient water to make 7 gallons.' This mixture will kill soft-

bodied species that are unprotected by a covering scale, such as *Lecanium viride*, *Pulvinaria psidii*, and *Dactylopius citri*. It has little or no effect against the *Diaspidinæ*.

Lime Water.—In the early days of the 'green coffee bug' I used a very thin wash of quick-lime and water. The mixture is inconvenient or difficult to apply as a spray, as it quickly clogs the nozzles and valves of the machine. I applied it with large brushes to the affected coffee foliage, and it was certainly fatal to every insect with which it came in contact. The bugs turned from green to a bright orange colour within five minutes of the application. But many individuals necessarily escaped, and the benefit was only temporary. No damage to the trees was observed, but the lime had such a caustic effect upon the hands and arms of the coolies employed in the work that it had to be discontinued.

Strawson's Mixtures.—I have recently had the opportunity of experimenting with a mixture supplied by the Strawson Company for use against the Tea-mite, and have found it very effective against scale insects of all kinds. It is one of the few insecticides that I have found of real value against *Orthezia*. Applied as a spray in the strength of 1½ lbs. to 4 gallons of water, it not only kills this insect, but prevents the hatching of the eggs also. This is apparently effected by the blocking of the aperture of the ovisac, and so preventing the emergence of the young insects. The mixture (as supplied) is of a soapy nature, and it is the soap that is probably the active agent in the destruction of the scale insects. The ingredients are naturally kept secret by the manufacturers, for which reason I am unable to recommend its use as a spray for tea during the 'plucking' season, but for the removal of scale insects upon other trees it will be found of value, and I have frequently used it advantageously to clean the stems of *pruned* tea. It is particularly effective also against the ants (*Cremastogaster Dohrni*) that give such trouble by building their nests in the tea bushes. These nests always enclose a colony of scale insects (usually *Lecanium formicarii*), and to prevent the recurrence of the ants it is most necessary to get rid of the bugs that attract them. For application to the stems of trees a large paint brush can be used in place of the spraying machine.

McDougal's Insecticide Wash.—This is another very useful patent insecticide, also of a soapy nature. As the ingredients are kept secret, the same objection applies to its extensive employment upon tea plants. It is equally effective against scale insects.

The two mixtures (Strawson's and McDougall's) were tested upon *Orthezia* with similar beneficial results. It is used as a spray.

The above two insecticides may be safely employed against 'green bug' or 'mealy bug' on coffee, and would be found very beneficial in checking these pests *where they are confined to a small area*. The treatment would be too expensive over a large acreage, and would be useless unless applied very thoroughly.

Adhatoda.—A decoction made by steeping the leaves of *Adhatoda vasica* (an Indian plant) in water is said to have proved beneficial against various insect pests in India, but I can find no record of its effect upon scale insects. Dr. Watt (Reporter on Economic Products to the Indian Government), who first brought into notice the properties of the plant as an insecticide, states that it has a distinctly paralysing effect upon many insects. But he appears to have found it unsatisfactory and uncertain in general use. The plant grows in Ceylon. In Trimen's *Handbook of the Flora of Ceylon* it is said to occur in the 'low country, common in hedges and waste places, especially in dry regions, but usually planted, and scarcely a native.' I obtained a few leaves and made a strong decoction from them. The amount of material was insufficient for extensive experiment, but leaves affected by various insect pests were dipped into the mixture. I was surprised to find it absolutely ineffectual. Even such soft-bodied insects as aphides, when thoroughly wetted with the mixture, were as lively as ever the next morning. Possibly the Ceylon-grown plant does not acquire the insecticidal properties noticeable in the Indian plant.

It may here be as well to mention a few other supposed remedies for the cure of scale bug, that are really quite valueless for the purpose. The beneficial results that have been attributed to them are probably due to some fortuitous circumstance, such as the treatment having been applied at a time when the pest was declining from natural causes. Such errors of observation have led to much waste of time and money.

The application of 'Mana grass' (*Andropogon nardus*), was at one time considered a cure for the coffee bug (*Lec. coffeæ*). Nietner, in his *Enemies of the Coffee Tree*, mentions that it was customary to bind the grass round the stems of the trees. I have repeatedly tried this plan, at various times of the year. I have tied the grass round the stems as directed, have spread it on the ground, and strewn it over the foliage. But in no case have I been able to observe the very slightest benefit from its use.

Soot is another article that has been greatly over-rated as an insecticide; and wood ashes may fall under the same category. These substances are, doubtless, useful in dealing with slugs and snails, their astringent and absorptive properties acting upon the mucous surface of such animals; but, when applied to dry insects, such as caterpillars and scale bugs, they fail to adhere, or, when adhering, to act in any way prejudicial to the insect.

Lime, when applied dry, has little or no effect, unless there happen to be moisture upon the insects. Even then its action will be very partial and unsatisfactory.

Powdered sulphur is also quite useless against scale insects.

Many other substances have been made the subjects of experiment; but, as they are either far too costly or otherwise impracticable, it is useless to enumerate them.

In the foregoing notes I have endeavoured to gather together the most reliable information on the subject of insecticides applicable to the treatment of Coccid pests. I present it to my subscribers, hoping that from amongst the various processes some treatment may be found to suit any case that may come under their notice.

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Dry Lime	xli
Sulphur	xli

CHIONASPIS, *Signoret.*

(PLATE XXXI.)

Chionaspis, Sign. '*Essai*,' 1869, p. 442 (124).

Species with female puparium elongate or elliptical: usually dilated behind. Pellicles overlapping; situate at anterior extremity. Ventral scale variously developed; either thin and delicate, adhering to the plant; or stout and remaining attached to the dorsal parts, on the displacement of the puparium. There is a very wide range in the form of the puparium. In some species it is very long and narrow (*elongata*). In others it is so widely dilated as to appear almost circular (*varicosa*, *dilatata*, *biclavis*). But in all cases the anterior pellicle will be found to project beyond the margin.

Male puparium as in *Diaspis* and *Fiorinia;* oblong, narrow; more or less distinctly tricarinate. The secretionary area is usually opaque white; but in one species (*minuta*) it is glassy and transparent. In another species (*acuminata*) there is a distinct reddish colouring matter in the furrows between the carinæ. Very little variety is found in the form of the male puparium in this genus, the chief differences lying in the degree of development of the carinæ.

Adult female oblong. Abdominal segments usually well defined, often produced laterally into conspicuous tubercles (*aspidistræ*, *mussændæ*). First pair of spiracles situated on the prothorax, close to the rostral apparatus. Second pair, on the metathorax, near its junction with the mesothorax. There are normally three free abdominal segments above the pygidium; but in two species (*galliformens* and *simplex*) the fourth segment, which ordinarily forms the base of the pygidium, is distinctly separated from the terminal segment. The pygidium is usually provided with a median and two lateral pairs of lobes; but there are considerable differences in the amount of their development. One or both of the lateral pairs may be obsolete, and in some abnormal forms (*e.g.*, *simplex*) all the lobes have disappeared. Two distinct types are noticeable, which are of assistance in grouping the numerous species:—

1. Species in which the median lobes are in close apposition, appearing almost continuous (*fig.* 1, Plate XXXI.).
2. Species in which the median lobes are separate and more or less divergent.

The second group may be subdivided into species in which the median lobes project freely from the margin (*fig.* 2), and others in which these lobes occupy the sides of a deep median cleft (*fig.* 3). These two latter forms, however, merge into each other. One or both pairs of lateral lobes are frequently suppressed, especially in the first group, o which *aspidistræ* may be taken as the type. When present, the lateral lobes are duplex, the mesal lobule usually larger than the other. The squames are tapering and spiniform, the extremity perforate and communicating with small filiform spinneret ducts. On the dorsal surface there are usually definite series of conspicuous oval pores (*fig.* 4),

which communicate with short, stout, cylindrical ducts. A few similar pores open on definite marginal prominences, of which there are—in typical forms—one on the second, and two on each of the third, fourth, and basal spaces. The circumgenital glands, when present, are normally in five groups. In one abnormal species (*simplex*) seven groups appear.

It will here be convenient to correct an error that appears in Part I. (p. 31). It is there stated—of the genus *Chionaspis*—that the anal is usually slightly above the genital aperture. More extended observation shows that their relative positions vary. The genital orifice occupies an approximately central position on the ventral surface of the pygidium, and the anal aperture may be situate either slightly above or below it on the opposite surface. The same correction must be made for the genus *Diaspis*.

For purposes of comparative description the pygidium of typical *Chionaspis* may be marked out into six different tracts (Pl. XXXI. (*fig.* 4, A–F), which I believe will be found to approximately correspond with the areas of suppressed segments. There are no really definite lines of demarcation to be found on the natural object; but we are assisted in determining their position partly by a few interrupted chitinous thickenings of the body wall, by the direction of the superficial folds, and by the series of oval pores. *Fig.* 4 is a diagrammatic view of the dorsal surface. The series of oval pores, judging from their position on the abdominal segments, may be taken as indicating the posterior border of each tract. The intersegmental line cuts the margin at the incision immediately anterior to each squame or group of squames. Starting from the centre, the mesal space (A) includes the anal aperture, and tapers downwards to a point between the median lobes. In species where the median lobes are widely separate there is sometimes a pair of minute squames or spines on the margin. The margin of the first lateral space (B) carries one of the median lobes, a spine, and one or more squames. The second lateral space (C) has a pore-bearing prominence, the first lateral lobes, a spine, and one or more squames. The third lateral space (D) has the same marginal character as the second, with the addition of an oval pore at the base of the lobes—between the lobules. The fourth lateral space (E) has two pore-bearing prominences, a third smaller prominence, a spine, and one or more squames. The fifth lateral, or basal space (F), is similar to the preceding, but broader at the margin, and bearing a larger group of squames. The series of oval pores are broken into two groups on each side, and are usually confined to the third, fourth, and fifth spaces, though they occasionally occur on the others.

The divisions of the ventral surface are not so readily made out. The demarcation in the diagram (Plate XXXI., *fig.* 5) is more or less tentative. The mesal space (A) is taken as consisting of a narrow tract, bounded above by the genital orifice and impinging upon the margin between the median lobes. The first lateral space (B) includes the median group of circumgenital glands. The second lateral space (C) encloses the anterior lateral groups. The third lateral space (D) carries the lower lateral groups. On the fourth and basal spaces (E, F), and often on the second and third abdominal segments, are more or less definite glandular scars, irregularly reticulate or lobulate. I believe these latter organs to be homologous with the grouped circumgenital glands. In an example of *Ch. hedyotis* I have in one instance found the glandular scar on one side of the fourth space replaced by a supernumerary group of normal glands.

There are no oval pores on the ventral margin. The genital opening is situate at the junction of the mesal and first lateral spaces. There is usually, on each space, a series of three or more minute tubercles, each surmounted by a small spine. In some species oval or circular pores occur, in connexion with small spinneret ducts ; but, when present, they are nearly always smaller and less conspicuous than those on the dorsal surface. The secretion thrown out from the oval pores is in the form of a strap-shaped filament, while the squames produce fine silky threads (see Plate XLIII., *fig.* 7).

The above constitutes the normal arrangement in species of which the European *Ch. vaccinii* may be taken as the type. But numerous exceptions and variations occur, which will be noted in the descriptions of the several species. An arrangement of nearly the same kind was suggested by Mr. A. C. F. Morgan in his 'Observations on Coccidæ, No. 3' (*Entomologists' Monthly Magazine*, Feb. 1889, pp. 189 *et seq.*). But Mr. Morgan traces the segmental divisions in a slightly different way to those here indicated, and allows for five segments only, no mesal tract being recognised. Mr. Morgan makes the marginal lobe the lateral termination of each segment. I am inclined to place the division laterad of the spiniform squame.

Adult male as in *Diaspis*. Antennæ usually with a single knobbed hair at extremity. The rudimentary eye seldom prominent, often represented only by an inconspicuous dark spot on genæ, or altogether suppressed.

In all respects the genus *Chionaspis* approaches very closely to *Diaspis*. The single point of difference appears to be that in *Diaspis* the pellicles of the female puparium are completely surrounded by the secretionary area, while in *Chionaspis* the first pellicle always projects beyond the anterior margin.

It is remarkable that, out of the twenty-six species here described, twenty-three are at present peculiar to Ceylon, three only (*aspidistræ*, *theæ*, and *biclavis*) having been recorded from other countries. And it is these very three (presumably imported) species that are alone of any economic importance.

It is extremely difficult to formulate a really serviceable synopsis of the numerous species at present included in this genus. Many of the species have distinctive characters that can only be appreciated by a comparison of the figures. The following arrangement will serve to indicate the main groups.

Synopsis of Species.

I. Median lobes approximate ; their inner edges in close opposition.

A. Median lobes small and inconspicuous. Anal below genital aperture.

(*a*) Female scale fulvous or reddish brown (occasionally whitish) thin and semi-transparent. Male puparia irregularly scattered. 1. *aspidistræ*.

(*b*) Female scale reddish brown ; opaque ; very long and narrow. Male puparia arranged in regular order .... 2. *theæ*.

(*c*) Scale white or greyish ; opaque .... 3. *albizziæ*.

B. Median lobes large and prominent. Anal above genital aperture.

(*a*) Female scale coated with fragments of the cuticle of the bark upon which it rests... 4. *mussændæ*.

(*b*) Female scale very thin and semi-transparent : colourless or very pale yellow ; concealed beneath the felted hairs of the leaf. 5. *rhododendri*.

(*c*) Female scale opaque white ; concealed within glandular pits on the leaf .... 6. *scrobicularum.*

II. Median lobes separate, more or less divergent.

A. Median lobes prominent.

(*a*) One pair of lateral lobes.

(*α*) Female scale white, dilated behind............... 7. *graminis.*

(*β*) Female scale white, narrow and very elongated not dilated behind... 8. *elongata.*

(*γ*) Female scale white ; secretionary area very small. 9. *arundinariæ.*

(*δ*) Female scale minute ; glassy ; colourless ; transparent. 10. *minuta.*

(*b*) Two pairs of lateral lobes.

(*α*) Circumgenital glands absent.

(i) Female scale yellowish, transparent. Adult insect black ; pygidium, in final stage, completely retracted. 11. *permutans.*

(*β*) Circumgenital glands in five groups.

(i) Female scale white. Lobes broad but not very prominent, scarcely projecting beyond margin .... 12. *herbæ.*

(ii) Female scale white, or coloured by particles of the cuticle of the plant. Lobes conical and prominent. Squames large and numerous .... 13. *polygoni.*

(iii) Female scale brownish fulvous ; with median ridge. Lobes small but prominent, squarely dilated at extremity. Dorsal pores irregularly disposed .... 14. *acuminata.*

(iv) Female scale colourless ; completely covered with the stellate hairs of the leaf. Lobes large and prominent, squarely dilated at extremity .... 15. *elæagni.*

(v) Female scale whitish ; thin and semi-transparent. Lobes conical ; small, but prominent .... 16. *vitis.*

(vi) Female scale white ; thin and semi-transparent. Lobes bluntly conical, rather inconspicuous and sunk into margin. 17. *hedyotidis.*

B. Median lobes sunk in a conspicuous cleft.

(*a*) Circumgenital glands in five groups. Female scale white or whitish.

(*α*) Anal below genital aperture .... 18. *litzeæ.*

(*β*) Anal above genital aperture.

(i) Median lobes small. Two pairs of lateral lobes. 19. *varicosa.*

(ii) Median lobes small. One pair of lateral lobes. 20. *dilatata.*

(iii) Median lobes very large..................... 21. *megaloba.*

(*b*) Circumgenital glands absent. Female scale yellow. 22. *flava.*

III. Median lobes large and prominent ; separate but not divergent. A pair of conspicuous club-shaped organs above the lobes. No circumgenital glands. 23. *biclavis.*

IV. Lobes present in early adult: afterwards obliterated by deposition of chitin. Female insect enclosed within the tissues of the plant. Four free abdominal segments. No circumgenital glands .... 24. *fodiens.*

V. Lobes altogether absent. Four free abdominal segments above the pygidium.

A. Circumgenital glands in five groups. Female scale concealed within gall-like swellings on the plant. Prominent marginal processes on pygidium simulating lobes .... 25. *galliformens.*

B. Circumgenital glands in seven groups. Female scale concealed beneath the leaf sheaths of the plant. No marginal projections on pygidium. 26. *simplex.*

EXPLANATION OF PLATE XXXI.

Pygidial Characters of Chionaspis.

Fig. 1. Extremity of Pygidium of *Ch. mussændæ;* with approximate median lobes.

2. Extremity of Pygidium of *Ch. polygoni;* with separate median lobes.

3. " " *Ch. varicosa;* with median lobes in cleft.

4. Diagrammatic plan of dorsal surface of pygidium of typical *Chionaspis.* (A), Mesal space. (B, C, D, E, F), first, second, third, fourth, and basal spaces, respectively.

5. Plan of ventral surface of pygidium. (Lettering as in *fig.* 4.)

CHIONASPIS ASPIDISTRÆ, *Signoret.*

(PLATE XXXII.)

Chionaspis aspidistræ, Sign., *Essai*, 1869, p. 443 (125).
Chionaspis braziliensis, Sign., *Essai*, 1869, p. 444 (127).

Female puparium (*figs.* 11, 12, and 13) variable in form, but always more or less elongate. In some examples (*e.g.*, a form on Areca palm), the puparium is narrow like that of *Mytilaspis*. In others (as in examples from *Capparis*), it is broadly dilated behind. Examples from *Cyanotis*—otherwise quite normal—have the puparium irregularly lobed (*fig.* 13), a formation due probably to interference by the hairs of the plant during the construction of the scale. (It will be noted that puparia of *Aspidiotus excisus*, on the same plant, are similarly lobed.) There is considerable variation also in the substance and colour of the scale. In some examples the secretionary area is thin and semi-transparent, of a pale fulvous tint: in others it is stouter and more opaque, the colour varying from whitish to reddish brown. In a large colony upon Areca palm, a few individuals were rendered conspicuous by having nearly opaque white puparia, while the rest of the colony were covered by reddish fulvous scales. No difference could be detected in the structural characters of the insects themselves. Pellicles yellowish; the second from two to two and a third times as long as the first. The proportionate length of the pellicles to that of the complete scale varies greatly, even in individuals of the same colony. The posterior extremity of the second pellicle (*fig.* 17) bears almost the same characters as those of the adult insect. Size of scale variable. Examples from 'Mango' average 1·60 by 1·0 mm. The narrow form from Areca palm measures about 2·0 by 0·60, whilst the broad form from *Capparis* averages 2·40 by 1·75 mm., numerous other examples forming the connecting links.

Male puparium (*fig.* 2), snowy white; elongate, narrow, sides sub-parallel; distinctly tricarinate, the carinæ smooth and regular. Long 1·0 mm. It is remarkable that, while in some forms (*e.g.*, those on Fern, *Strobilanthes*, *Amomum*, Pepper, &c.), the male scales greatly predominate; in others (on Areca palm and *Acacia melanoxylon*) they apparently never occur.

Adult female oblong; broadest across the abdominal segments, which (in the early adult) are strongly marked and laterally produced into bluntly conical processes (*fig.* 9). In some examples there is a lateral prominence on the metathoracic segment also. These processes become less conspicuous, or even obliterated, after oviposition. Colour pale yellow tinged with red on the median area (*fig.* 9), deepening, with age, to brownish red. Eyes blackish, on small marginal prominences. Antennæ with a stout curved bristle (*fig.* 14), which in some forms (from *Areca*, *Ficus*, and *Acacia*) is long and whip-like (*fig.* 15). Anterior spiracles with a distinct group of rather large parastigmatic glands; sometimes a very inconspicuous group of smaller glands above the second pair

also. Lateral margins of abdominal segments with groups of pores ; the third and fourth (sometimes the second), with two to four stout spiniform squames, those on the posterior segment longest. Pygidium (*fig.* 8) with a pair of small crenulate median lobes, their inner sides so closely applied that the division is often difficult to detect. In examples from Areca palm (*fig.* 16), the margin of the pygidium projects beyond the extremity of the median lobes. First lateral lobes duplex, the mesal lobule prominent and squarely truncate at extremity. Second lateral lobes almost obsolete, or represented by thickenings of the margin. The pore-bearing prominence of the first lateral space is often thickened and strongly chitinised, and may be readily mistaken for the true lobe which follows it. A single squame on each of the first to fourth spaces, and two or three on the base, decreasing in size towards the extremity of pygidium. Dorsal pores few, the series consisting of three or four on the fifth, and one or two on the fourth space—besides the usual marginal pores. Circumgenital glands in five groups. The number of orifices has a rather wide range of variation, the lowest extreme being that of the form from the *Areca*, in which the median group averages 4, the upper laterals 11, and the lower laterals 12 ; while examples from *Capparis* show 16 orifices in the median group, 22 in the upper laterals, and 28 in the lower laterals. Of the intermediate forms a general average gives 7 in the median, 16 in the upper, and 18 in the lower lateral groups. In every case the lower laterals average the greater number of orifices. The anal orifice is situate immediately opposite or slightly posterior to the genital aperture. The size of the female insect is equally variable, but depends partly upon the period at which it is taken. A fully extended specimen, before oviposition, averages 1·20 by 0·50 mm. But the insect is usually found in the collapsed condition, when macerated examples measure about 0·75 by 0·40 mm.

Adult male (*fig.* 1), bright reddish, ocelli black. A dark spot on each side of the genæ represents the rudimentary eye. Legs and antennæ yellowish. Foot (*fig.* 3) with two digitules (one ungual and one tarsal). Antennæ almost as long as the body, hairy, a single knobbed hair at apex (*fig.* 4). Total length about 1·0 mm.

Egg (*fig.* 5) reddish fulvous.

Newly hatched larva (*fig.* 6) pale yellowish.

Habitat. This is one of the most widely distributed species of the genus in Ceylon, and occurs on a very large number of plants. I have taken it on Areca palm, *Acacia melanoxylon*, *Strobilanthes viscosus*, *Capparis moonii*, *Amomum*, Mango, *Ficus*, *Cyanotis*, Pepper, and various cultivated ferns in Pundaluoya : on *Croton*, *Alocasia*, and *Pothos* in Colombo. A form with whitish scales occurs on *Gaultheria fragrans* at Ambuwella and Nuwara Eliya. This species is recorded also from India, and is a common greenhouse pest in Europe.

It is possible that a more critical examination may result in the specific separation of the several forms described above ; but, though differing in many minute points, they merge into each other so gradually, and the main structural characters are so much alike, that they can quite conveniently be retained under the single name.

The colonies are often very extensive, and this species must be considered a distinctly injurious one. I have frequently seen young Areca palms in which every frond was covered on both sides with the insects, the fronds appearing yellow instead of green, from the multitude of discoloured spots, each of which

marks the position of one of the insects. Their continued presence must be very exhausting to the plant. While the palms are still small it would be easy to treat them with one of the usual washes—either kerosine emulsion, Strawson's mixture, or one of the other soapy emulsions mentioned in the chapter on insecticides. The wash might be applied by a spraying machine, or, where the number of trees to be treated is not large, better results would be obtained by going over each frond with a sponge or cloth soaked in the mixture.

One of our large ladybird-beetles (*Chilochorus circumdatus*) does good service in reducing the numbers of this insect, and, where they are found to be present in force, they should not be disturbed by the application of washes, but allowed to continue their good work, which will be more effective than any artificial remedy. I have frequently found the remains of a large colony of the bug in which every single scale had been opened and the contents devoured by this beetle, which is equally voracious in both the larval and adult stages. Our ladybird, being an indigenous species, is handicapped by the presence of its own natural enemies ; but, if it could be successfully introduced into some othe country, it would probably prove most useful.

EXPLANATION OF PLATE XXXII.

CHIONASPIS ASPIDISTRÆ.

(*All figures, except No.* 10, *more or less enlarged.*)

Fig. 1. Adult male, dorsal view.
2. Male puparium, from above.
3. Foot of adult male.
4. Terminal joint of antenna of male.
5. Egg.
6. Young larva.
7. Adult female (from *Acacia*), ventral view.
8. Pygidium of female (from Fern).
9. Adult female (from Fern), dorsal view.
10. Piece of Fern (*Thamnopteris nidus*) with insects *in situ*, nat. size.
11. Female puparium, early adult (from Fern).
12. " " later stage " "
13. " " (from *Cyanotis*).
14. Antenna of female (from Fern).
15. " " (from *Acacia*).
16. Pygidium of female (from *Areca*).
17. Posterior extremity of second pellicle (from Fern).

CHIONASPIS THEÆ, *Mask.*

(Plate XXXIII.)

Chionaspis theæ, Maskell, 'Catalogue of Coccidæ,' *Indian Museum Notes*, Vol. II., No. 1, p. 59 (1891).

Chionaspis exercitata, Green, *Ind. Mus. Notes*, Vol. IV., No. 1, p. 3 (1896).

Female puparium (*fig.* 9) long and narrow; sides sub-parallel; often slightly concave above owing to its situation along the hollow of one of the veins or by the midrib. Colour, pale reddish or brownish fulvous; sometimes bleached to a whitish tint; always very inconspicuous. Pellicles yellow, the first less than half length of second. Total length of fully developed scale 2·75 to 3·25 mm. Breadth averaging 0·50 mm.

Male puparium (*figs.* 1 to 7) snowy white; strongly tricarinate; the carinæ very prominent and irregularly waved; pellicle yellow. Length 1·10 mm. The male scales are not disposed irregularly, but congregated in definite patches, the individuals lying parallel with each other, and all pointing in the same direction (*fig.* 8).

Adult female (*fig.* 10) oblong, narrowest in front; abdominal segments distinct, with well-marked protuberances on each side. Colour purplish red, pygidium yellowish. Anterior spiracles with distinct parastigmatic glands, a single glandular pore above each of the second pair. The third and fourth (rarely the second) abdominal segments each with two stout spiniform squames Pygidium (*fig.* 11) with the lobes and other marginal characters as in *Ch. aspidistræ.* In the preliminary description of the species (*Ind. Mus. Notes*, *loc. cit.*) it is stated that there is a single undivided median lobe; but better preparation, with the aid of stains, shows that a division exists, though inconspicuous and difficult to detect, and that the apparently single median lobe consists of the usual pair with their inner faces contiguous. Dorsal pores few: a short series of 2 to 3 on base, and usually only a single pore on the fourth space. Circumgenital glands in five groups; median with a nearly constant number of 8 orifices; upper laterals with from 18 to 25; lower laterals, 16 to 18, the upper laterals having nearly always the larger number of orifices. Length 1 to 1·25 mm. Greatest breadth 0·40 mm.

Adult male (*fig.* 12) bright red; apodema paler; legs yellowish. Ocelli large, black; lower pair separate by nearly their own diameter. Rudimentary eyes not apparent. Antennæ as long as the body of the insect; tenth joint much shorter than ninth, a curved knobbed hair at its apex (*fig.* 13). Foot (*fig.* 14) with two digitules (1 ungual and 1 tarsal). Tarsus as long as tibia. Length about 1 mm.

Eggs and young larvæ dull red.

Habitat on upper surface of leaves of Tea plant, *Psychotria*, and other shrubs—Pundaluoya, Kandy, Balangoda. The species occurs also in the

Indian tea districts. The patches of snowy white male puparia, all ranged in definite order, form conspicuous objects on the dark green tea leaves (*fig.* 8).

Though occurring rather commonly in Ceylon, I have never seen this insect in injurious numbers. More serious damage has been reported from the Indian tea districts.

The male scales are very much more numerous than those of the female. A large group of male scales is often accompanied by only a single female, which is probably the parent of the colony. Possibly the female larvæ have wandered further afield.

This species is very closely allied to *aspidistræ*. The chief superficial distinctions are the unusually long and narrow puparium of the female, the disposition, and the very prominent ridges of the male scales. The structural differences are not very important, the principal being the relatively larger number of orifices in the upper lateral groups of the circumgenital glands. It should, perhaps, rank merely as a well-marked variety of *aspidistræ*.

A form in which the female puparium is white was collected in Nuwara Eliya upon *Eurya japonica*, a plant allied to tea.

EXPLANATION OF PLATE XXXIII.

CHIONASPIS THEÆ.

(*All figures, with exception of No.* 8, *more or less enlarged.*)

Figs. 1, 2, 3, 4, 15. Successive stages in growth of male puparium.
Fig. 6. Male puparium, from below, showing pupa *in situ*.
7. " " side view.
8. Leaf of tea plant, with insects, nat. size.
9. Female puparium, from above.
10. Adult female, ventral view.
11. " " pygidium, dorsal view.
12. Adult male, dorsal view.
13. " " terminal joints of antenna.
14. " " foot.

CHIONASPIS ALBIZZIÆ, *sp. nov.*

(PLATE XXXIV.)

Female puparium opaque snowy white, often specked with brown (*fig.* 2) from the incorporation of fragments of the cuticle of the bark: rather broadly dilated behind. Pellicles fulvous, the second deeply tinged with reddish brown. In fully developed examples the second pellicle occupies a little less than one-third the length of the puparium. First pellicle half length of second. Ventral scale thin, remaining attached to plant. Length 1·50 to 2 mm.

Male puparium (*figs.* 8, 9) snowy white; narrow, sides almost parallel, posterior extremity slightly wider; distinctly tricarinate; the ridges even and moderately smooth. Pellicle fulvous. Length 1 mm.

Adult female (*figs.* 3, 4) oblong, broadest across the abdomen; abdominal segments distinctly marked, with prominent lateral margins. Colour at first clear reddish orange, afterwards becoming darker from the accumulation of the contained ova, giving the insect a deep purplish tinge in the middle (*fig.* 3): older examples become more or less uniformly purplish brown. Antennæ with a single longish curved bristle. Minute reddish eye-spots can usually be distinguished in the living insect, situated on small marginal prominences. Anterior spiracles with a small group of parastigmatic glands. A few pores on lateral margins of metathorax and each of the abdominal segments. A group of three or four spiniform squames on second and third abdominal segments. Single squames on first to fourth spaces of the pygidium, and two or three on the base. Median lobes of pygidium prominent, their inner edges in close apposition (*fig.* 6); emarginate, slightly truncate at extremity. First lateral lobes minute but prominent. Second lateral lobes almost obsolete, their position indicated by a serrate thickening of the margin. The usual marginal pores. Dorsal pores few; a double series, consisting of five or six, on the base of the pygidium, and a single pore on the fourth space. Circumgenital glands in five groups; median with 6–11 orifices; upper laterals 14–17; lower laterals 12–17. Genital aperture about the middle of the pygidium; anal orifice slightly nearer the extremity. Length of extended example 1 to 1·12 mm.

Adult male bright red; a prominent dark spot on genæ representing the rudimentary eyes (*fig.* 10). Terminal joint of antenna with single knobbed hair at apex. Foot with two digitules, one ungual and one tarsal. Length about 1 mm.

The early scale of the female (of second stage) is thin and semi-transparent, showing the colour of the insect through it (*fig.* 7); the surface closely frosted with white specks.

Egg (*fig.* 5) oblong, frequently distorted and unsymmetrical; reddish or brownish-purple.

Habitat on stems of *Albizzia stipulata* and allied species. Also on *Pithecolobium saman.* Occurring often in such numbers that the whole surface

of the tree appears to be covered with white scurf. When young trees are attacked, their growth is much retarded. It is fortunately extensively preyed upon by a large yellowish brown 'ladybird' beetle (*Chilochorus circumdatus*), which clears off whole colonies at a time. It is also much parasitised by two distinct hymenopterous insects (*Prospalta aurantii*, How., and *Aphelinus diaspidis*, How.). Common in Pundaluoya, Jan.—May.

EXPLANATION OF PLATE XXXIV.

Chionaspis albizziæ.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of *Albizzia* stem, with male and female scales, nat. size.
2. Female puparium, from above.
3. Adult female, dorsal view.
4. „ „ more enlarged, after maceration.
5. Egg.
6. Pygidium of adult female, ventral view.
7. Female scale, second stage.
8. Male puparium, from above.
9. „ „ side view.
10. Head of adult male, dorsal view.

CHIONASPIS MUSSÆNDÆ, *sp. nov*

(Plate XXXV.)

Chionaspis aspidistræ, var. *mussændæ*, Green, 'Catalogue of Coccidæ,' *Indian Museum Notes*, Vol. IV., No. 1., p. 2 (1896).

Female puparium very inconspicuous and difficult to detect, concealed by a covering of the surface hairs (*fig.* 9), or fibres (*fig.* 8) of the bark, and consequently varying in appearance according to the nature of the part of the plant to which it is attached. Actual colour of the scale where not concealed by the superimposed material greyish white. Form oblong oval, or dilated behind. Pellicles very pale yellow; the second usually concealed. Posterior extremity of second pellicle with very prominent median lobes (*fig.* 13). Length 2·50 to 3·25 mm. Breadth 1·50 to 1·75 mm.

Male puparia snowy white; strongly tricarinate (*fig.* 2); collected into conspicuous groups (*fig.* 6), in which the individuals are crowded together, each scale erect and attached by the anterior extremity only. When first formed they are often densely covered with silky filaments; but these afterwards fall off, leaving the puparium fully exposed. Length about 1·25 mm.

Adult female of same form and general appearance as *aspidistræ*, but much larger and more robust. Colour varying from yellow (*fig.* 10) to dull orange (*fig.* 12); older examples with median area suffused with brownish red (*fig.* 11). Margins of abdominal segments, and often those of meso- and meta-thorax, with conspicuous lateral processes (*fig.* 12). After oviposition the lateral processes disappear (*fig.* 11). Margins of the segments with groups of oval pores, and four to seven stout spiniform squames on lateral margins of second and third abdominal segments. In the living insect the four spiracles are marked by conspicuous white waxy patches secreted by the parastigmatic glands. Pygidium (*fig.* 7), with median lobes large, prominent, and conspicuous, their inner edges in close apposition, the free edge sloping and crenulate. Other lobes obsolete. Squames stout, one on each of first to third spaces, two on fourth space, and a group of five to seven on base. Dorsal pores as in *aspidistræ;* sometimes a double series on base. Circumgenital glands in five groups, with numerous orifices: median 19 to 24; upper laterals 30 to 38; lower laterals 27 to 35; the upper laterals always with the larger number. Anal aperture between the upper lateral groups, considerably above the level of the genital orifice. Length of extended example 1·50 to 1·75 mm. Greatest breadth 0·75 mm.

Adult male (*fig.* 1), bright brick-red. Form normal. Antennæ with a single knobbed hair at extremity (*fig.* 5). Foot (*fig.* 4), with one tarsal and one ungual digitule. Tarsus nearly as long as tibia. Length rather more than 1 mm.

Eggs and young larvæ brownish red.

Habitat on the bark of the small branches and twigs of *Mussænda frondosa;* occasionally upon *Loranthus* and *Debregæsia.* Pundaluoya.

A much larger and more robust species than *aspidistræ*, from which it may be distinguished by the larger and more prominent median lobes, and by the relative positions of the anal and genital orifices. The second pellicle also affords useful specific characters, that of *mussændæ* having large and prominent median lobes at the posterior extremity, the same parts in *aspidistræ* being minute and sunk into the margin (compare Plates XXXV., *fig.* 13, and XXXII., *fig.* 17). The unusual erect position of the male puparia is characteristic of the species.

The female insect is very frequently parasitised by the minute hymenopteron, *Aphelinus diaspidis*, How.

EXPLANATION OF PLATE XXXV.

CHIONASPIS MUSSÆNDÆ.

(*All figures, except No.* 6, *more or less enlarged.*)

Fig. 1. Adult male, dorsal view.
2. Male puparium, from above.
3. „ „ diagrammatic section.
4. Leg of adult male.
5. Terminal joint of male antenna.
6. Twig of *mussænda*, with insects *in situ*, nat. size.
7. Pygidium of adult female.
8. Female puparium, from older (smooth) bark.
9. „ „ from the young (hairy) bark.
10. Adult female, ventral view, before oviposition.
11. „ „ „ „ after „
12. „ „ dorsal view.
13. Posterior extremity of second pellicle.

CHIONASPIS RHODODENDRI, *sp. nov.*

(PLATE XXXVI.)

Female puparium (*fig.* 2) oblong, narrowed in front, dilated behind, often irregularly curved. First pellicle very pale fulvous: second pellicle concealed beneath the covering of hairs that adhere to the whole surface of the scale. Secretionary area very thin and delicate; colourless or slightly tinged with ochreous, the tint being partly due to the incorporation of the leaf hairs. Length 1·25 to 1·50 mm. Greatest breadth about 0·75 mm.

Male puparium (*fig.* 3) of normal form; slightly wider behind; indistinctly tricarinate, the lateral carinæ almost suppressed. Colour dead white; pellicles very pale yellowish. Length 0·75 mm.

Adult female (*fig.* 4) oblong, widest across the median area; in fully extended examples the length exceeds twice the breadth. Colour bright pale yellow; extremity of pygidium tinged with reddish. Anterior spiracles with a small group (three or four pores) of parastigmatic glands. Margins of metathorax and abdominal segments slightly produced, and bearing a few oval pores; the second and third abdominal segments with two or three spiniform squames. Pygidium (*fig.* 5) with a very prominent pair of large median lobes, their inner edges in close apposition, their free outer edges together forming a semicircle with finely crenulate margin. First lateral lobes duplex, small and obscure: second lateral lobes obsolete. Single squames on first and fourth spaces; usually three squames on base. Marginal spines rather large and conspicuous. The usual marginal pores. One or two oval dorsal pores on fourth space, and a series of three or four on base. Circumgenital glands in five groups, median, 6 to 8; upper laterals, 11 to 15; lower laterals, 10 to 15. Anal usually slightly above genital aperture; the two apertures sometimes superimposed. Length of fully extended example 1 to 1·25 mm. Greatest breadth about 0·40.

Adult male not observed.

Habitat on under surface of leaves of *Rhododendron arboreum.* Nuwara Eliya (March, April). The position of the insects can only be detected by the small yellow discoloured spots on the smooth upper surface of the leaf (*fig.* 1). The scales themselves are completely hidden beneath the densely felted hairs that clothe the under surface of the leaf. The male scale is similarly situated; but the posterior extremity is inclined upwards through the pilose covering of the leaf, to permit the easy exit of the winged adult.

In spite of this apparently perfect protection, a very large proportion of the insects are parasitised. In fact, I have found it extremely difficult to obtain uninjured examples.

The species is nearly allied to *Ch. scrobicularum*, from which it may be distinguished by its more elongate form, narrower and more pointed pygidium, and the scarcity of dorsal pores, as well as by its very different habitat.

EXPLANATION OF PLATE XXXVI.

CHIONASPIS RHODODENDRI.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Rhododendron leaf showing discoloured spots on upper surface which mark the position of the insects below.

2. Female puparium.
3. Male ,,
4. Adult female, ventral view.
5. Female pygidium, dorsal view.

CHIONASPIS SCROBICULARUM, *sp. nov.*

PLATE XXXVII.

Female puparia concealed within the glandular pits (scrobiculæ) at the base of the veins, on under-surface of leaves of *Elæocarpus amœnus*, their presence indicated by a white powdery secretion at the orifice of the cavities (*fig.* 1). Sometimes one of these pits is completely occupied by a single puparium (*fig.* 2), or the cavity may contain several individuals of both sexes (*fig.* 3). Occasionally an individual, crowded out of the cell, forms an exposed puparium on the surface of the leaf. In such examples the puparium is of the normal form, dilated behind. Examples in the pits are often distorted and irregular in form from over-crowding. The yellowish pellicles are often nearly concealed by a covering of waxy secretion. Colour opaque white. Length 1 mm. Breadth 0·70 mm.

Male puparium similarly situated ; usually several together ; oblong ; form rather irregular (*fig.* 4) ; white, with the colour of the contained insect showing indistinctly through the scale ; scarcely carinate, a median ridge represented only by a line of more opaque secretion ; the whole puparium dusted over with mealy matter. In exposed examples the carinæ are rather more distinct. Length 1 mm.

Adult female (*figs.* 6, 7) bright gamboge yellow ; extremity of pygidium reddish. Form normal ; narrowed in front ; broadest across the median segments (metathorax and first abdominal). Anterior spiracles with a small and inconspicuous group of parastigmatic glands. Margins of metathorax and abdominal segments with large groups of oval pores. Pygidium (*fig.* 8) broad ; median lobes very prominent, their inner edges in close apposition, the two together forming a regular semicircle with finely crenulate margin. First pair of lateral lobes very minute, duplex ; other lobes obsolete. Squames spiniform, moderately stout and long ; one or two on each of first to fourth spaces, and three on base. The usual marginal spines springing from definite thickened patches. The pore-bearing prominence on first and second lateral spaces is produced into a spine-like process on one side. Dorsal pores numerous ; very irregularly disposed. Smaller circular pores are scattered over the ventral surface, communicating with short capitate filiform ducts similar to those opening into the squames. Two oblong chitinous thickenings of the dorsal surface on each side immediately exterior to the circumgenital glands, and conspicuously thickened lines running upwards from the extremity on the ventral surface. Circumgenital glands in five groups ; median 11 to 20 ; upper laterals 20 to 27 ; lower laterals 16 to 22 ; the upper laterals always with the larger number. Length 0·75 to 1 mm. Breadth about 0·50 mm.

Adult male bright reddish ; of normal form. Terminal joint of antenna (*fig.* 9) shorter than ninth ; broad at base ; the narrowed apical portion conspicuously darker after staining : a curved knobbed hair at apex. Foot with

three digitules, one on claw and two or tarsus. Length, including genital sheath, 0·75 mm.

Eggs and young larvæ pale yellow.

Habitat in small pits at base of veins on under surface of leaves of *Elæocarpus amœnus.* Pundaluoya.

EXPLANATION OF PLATE XXXVII.

Chionaspis scrobicularum.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Elæocarpus,* nat. size, showing glandular pits occupied by the insects.

2. A glandular pit opened, showing female puparium.
3. " " " showing group of male and female puparia.
4. Male puparium.
5. Terminal joint of male antenna.
6. Adult female, ventral view.
7. " " after maceration, showing position of the various organs.
8. Pygidium of female, dorsal view.

CHIONASPIS GRAMINIS, *Green.*

(PLATE XXXVIII.)

Chionaspis graminis, Green, 'Catalogue of Coccidæ,' *Indian Museum Notes*, Vol. IV., No. 1, p. 2 (1896).

Female puparium (*figs.* 2, 12, 13) snowy white; elongate, moderately dilated behind; ventral scale well developed, and often coming away unbroken with the dorsal parts (*fig.* 12). First pellicle very pale transparent fulvous; anterior margin rather deeply notched; antennal sheaths usually bent back and lying close along the margin. Second pellicle reddish (*fig.* 2) or fulvous (*fig.* 13), covered by a very delicate layer of secretion appearing as fine white transverse lines; sometimes, upon very fresh examples, three or more longitudinal white lines are noticeable (*fig.* 13), more especially in the second stage of the insect (*fig.* 11). Length 2 to 3·50 mm.; breadth 0·75 to 1·50 mm.

Male puparium (*figs.* 4, 5, 6) snowy white; elongate, narrow, sides nearly parallel; rather indistinctly carinate; at first thickly dusted with powdery secretion (*fig.* 5), which, in older examples, becomes rubbed off, leaving the puparium quite smooth (*figs.* 4, 6). Pellicle very pale fulvous (*fig.* 6), often tinged with brown (*fig.* 4). Length averaging 1 mm.

Adult female (*fig.* 3) bright orange colour; younger individuals orange yellow. Eyes faintly visible, reddish brown. Form elongate; thoracic and abdominal segments of about equal breadth; division of segments moderately distinct. Second and third abdominal segments each with a group of small spiniform squames. Both pairs of spiracles with conspicuous parastigmatic glands. Pygidium of typical form (*fig.* 10) with prominent median lobes, subparallel with rounded or bluntly pointed extremities. First lateral lobes prominent, duplex, mesal lobule twice as large as the other. Second lateral lobes obsolete. Squames strongly developed; in pairs on first to third spaces; sometimes paired on fourth space also; a group of five or six on base. Conspicuous oval pores in the usual series on third, fourth, and basal spaces. Some minute circular pores on ventral surface, connected with small capitate filiform ducts. Circumgenital glands in five groups: median, 14 to 16; upper laterals, 30 to 43; lower laterals, 20 to 27; the upper lateral groups always the larger. Anal and genital apertures at same level. Length 1·25 to 1·50 mm. Breadth 0·50 mm.

There is a very constant variety (*fig.* 9) which I distinguish as *var. divergens*, in which the extremity of the pygidium is blunter. Median lobes widely divergent, with pointed extremities. Two to three squames only on base. Orifices of circumgenital glands less numerous, median averaging thirteen; upper laterals, eighteen to twenty-four; lower laterals, fourteen to seventeen. In one example the left upper lateral group was wanting. The strongly divergent median lobes is the most important character.

Adult male bright orange red, a prominent dark spot on genæ representing the rudimentary eye. Form normal. Foot with three digitules, one on claw and two on tarsus.

Eggs and young larva (*fig.* 8) bright yellow. The eggs very numerous (*fig.* 7).

Habitat on upper surface of blades of 'Mana' grass, *Andropogon nardus.* Common wherever this particular grass occurs. The snowy white puparia are of themselves very conspicuous objects, but they are rendered still more so by a dark purple discolouration of the tissues of the leaf immediately surrounding them (*fig.* 1).

The typical form and the variety *divergens* are of almost equally common occurrence in the same localities. The two forms are absolutely indistinguishable except by microscopic examination.

Large numbers of the insects are destroyed by minute hymenopterous parasites, the pupæ of which, from one to three in number, may be found beneath the scale, with their heads always directed in the opposite direction to that of the host. The parasites have been examined by Prof. L. O. Howard, who finds three distinct species affecting this one scale insect, viz., *Encyrtus chionaspidis*, How., *Anthemus chionaspidis*, How., and *Aphelinus mytilaspidis* Le B.

EXPLANATION OF PLATE XXXVIII.

CHIONASPIS GRAMINIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of 'Mana' grass, with insects *in situ*, nat. size.
2. Female puparium, with reddish pellicle.
3. Adult female, dorsal view.
4. Male puparium, with brownish pellicle.
5. " " " powdery covering.
6. " " " pale pellicle.
7. Female puparium, from below, showing insect and ova.
8. Newly hatched larva.
9. Pygidium of female, var. *divergens.*
10. " " typical form.
11. Female puparium, of second stage.
12. " " from below, showing ventral scale intact.
13. " " from above, with pale pellicles.

CHIONASPIS ELONGATA, *Green.*

(Plate XXXIX.)

Mytilaspis elongata, Green, 'Catalogue of Coccidæ,' *Ind. Mus. Notes*, Vol. IV., No. 1, p. 4 (1896).

Female puparium white; very long and narrow (*fig.* 13); margin narrowly flattened. First pellicle very pale yellow; margin with a complete series of longish curved spines. Second pellicle elongate; pale reddish orange, darker at the sides; thinly coated with whitish secretion. Pellicles in fully developed puparia together occupying rather less than one third the total length. Ventral scale represented by a very narrow strip on each side of the median channel (*fig.* 14). Length varying according to age, the most mature specimens reaching a length of 3·50 mm., with a breadth of only 0·50 mm.

Male puparium (*fig.* 9) white; slightly widened and very obscurely carinated towards the posterior extremity. Ventral scale incomplete, represented by a narrow infolding of the margin along the anterior two thirds of the puparium (*fig.* 8). Pellicle very pale yellow. The male puparia are often partially concealed by an accumulation of loose curling filaments secreted by the insect in its earlier stages. These originate as a pair of brush-like tufts diverging from the hinder part of the larva (*fig.* 7). Length 1·25 mm.

Adult female (*fig.* 11) pale yellow, deepening to dull orange-yellow during gestation (*fig.* 10). Long and very narrow; the thoracic segments greatly elongated; the abdominal segments short, the second and third laterally produced and bearing two to three stout spiniform squames. The remarkable increase in length takes place apparently during gestation. The early adult, immediately after the second moult, is of the ordinary form; but the thoracic segments are minutely and closely wrinkled transversely, to allow of extension. On each side of the anterior extremity is a small marginal prominence corresponding to the elevated spot upon which the eye is situated in some species. Parastigmatic glands represented only by one or two inconspicuous pores at the anterior spiracles. Pigidium (*fig.* 12) rather pointed; median lobes divergent, prominent, pointed, their inner edges emarginate; first lateral lobes minute, duplex, the inner lobule prominent and squarely cut at extremity; other lobes obsolete. Squames large, decreasing in size towards extremity; one on each of first to fourth spaces, and two or three on base. Circumgenital glands in five groups: median, 4 to 6; upper laterals, 8 to 10; lower laterals, 10. Series of dorsal pores on fourth space, on base of pygidium, and on third abdominal segment. Anal slightly anterior to genital aperture. Length 1·25 to 1·50 mm. Breadth about 0·15 mm.

Adult male (*fig.* 2) bright red. Head rather small. Prothorax narrowed in front; mesothorax ample, but not very prominent dorsally. The four ocelli subequal in size, the lower pair rather widely separate. Antennæ a little

shorter than body : terminal joint with five knobbed hairs at side and one at apex (*fig.* 3). Foot (*fig.* 4) with four digitules ; tarsus a little shorter than tibia. Genital sheath about one quarter total length. Length 0·65 mm.

Female of second stage (*fig.* 5) with posterior margin similar to that of adult ; lateral margins of each of the preceding four or five segments with a large stout spiniform process.

Newly hatched larva pale greenish yellow ; terminal joint of antenna very long; a complete marginal series of spines arising from minute tubercles.

Egg greenish yellow (*fig.* 6) ; very oblong ; placed transversely in the channel of the puparium (*fig.* 14).

Habitat on leaves of bamboo (Arundinaria sp. ?). Pundaluoya, Nuwara Eliya (March, April). The insects occur on both upper and under surfaces of the leaves, but apparently prefer the latter. The female scales lie parallel with the axis of the leaf, with the anterior extremity usually directed towards the apex. The male scales are frequently collected together in small groups, and partially covered with loose cottony filaments. The species was abundant in Pundaluoya during the years 1892–95 ; but at the present time (1897) scarcely an example can be found in this locality. This would appear to be a case in which the natural enemies of the insect (hymenopterous parasites) have gained the mastery, and practically exterminated the species.

In general form this insect approximates closely to species of the genus *Mytilaspis*, such as *M. cordylinidis*, Mask.; but a careful examination of the male puparium shows that it is really, though obscurely, carinate, and lacks the hinge-like structure found in the male scales of typical *Mytilaspis*.

EXPLANATION OF PLATE XXXIX.

CHIONASPIS ELONGATA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of bamboo leaf, ♂ and ♀ insects *in situ*, nat. size.
2. Adult male, dorsal view.
3. „ „ terminal joint of antenna.
4. „ „ leg.
5. Female of second stage.
6. Egg.
7. Male larva, showing filamentary tufts.
8. Male puparium, from below.
9. „ „ „ above.
10. Adult female, ventral view.
11. „ „ dorsal view, before gestation.
12. „ „ pygidium.
13. Female puparium, from above.
14. „ „ „ below.

CHIONASPIS ARUNDINARIÆ, *sp. nov.*

(PLATE XL.)

Female puparium (*fig.* 3) whitish, very faintly tinged with ochreous ; of irregular outline, usually broadest immediately behind the second pellicle. Total length not greatly exceeding breadth. Secretionary area completely surrounding second pellicle ; often marked with furrows and ridges from the prominent ribs of the leaf. First pellicle very pale ochreous. Seen by transmitted light (*fig.* 4), the disc appears to be covered with small opaque gland-like spots, arranged in definite transverse lines on the posterior half ; margin set with stout curved spines. Second pellicle ochreous, darker and more opaque towards margin and hinder extremity ; very irregular in form (*fig.* 5). Total length 1·25 to 1·50 mm. Breadth 1 mm.

Male puparium (*fig.* 2) white ; very thin and delicate ; faintly carinate ; sides sub-parallel. Pellicle pale ochreous, with opaque spots and marginal spines. Length 1 mm.

Adult female (*fig.* 1) oblong, broadest across mesothorax ; bright pale yellow. Margins of meso and metathorax with one or two small conical tubular processes. Spiracles without definite parastigmatic glands. Abdominal segments without dorsal pores or marginal squames. Pygidium (*fig.* 6) with a slight median indentation. Median lobes rather small, divergent, pointed, their free edges irregularly dentate. First lateral lobes duplex, very minute and inconspicuous. Other lobes obsolete. Squames large and prominent ; one on each of the first to fourth spaces, none on base. Series of oval dorsal pores on third, fourth, and basal spaces. Circumgenital glands in five lax groups : median, 3 to 4 ; upper laterals about 6 ; lower laterals about 8. Anal slightly anterior to genital aperture. Length about 0·75 mm. Greatest breadth 0·40 mm.

Adult male not known.

Habitat on under surface of leaves of bamboo (*Arundinaria sp.*). Kelani Valley, Udagama.

A small and inconspicuous species. Allied to *elongata*, but easily distinguished by the form of the scale.

EXPLANATION OF PLATE XL.

CHIONASPIS ARUNDINARIÆ.

Fig. 1. Adult female, ventral view.
2. Male puparium, from above.
3. Female puparium, from above.
4. „ „ first pellicle.
5. „ „ second pellicle.
6. Pygidium of adult female, dorsal view.
7. Margin of metathorax, with tubular processes.

CHIONASPIS MINUTA, *Green.*

(PLATE XLI.)

Chionaspis minuta, Green, 'Catalogue of Coccidæ,' *Ind. Mus. Notes*, Vol. IV., No. 1, p. 3 (1896).

Female puparium colourless, transparent, showing the yellow body of the insect and the eggs below (*figs.* 2, 3). Pellicles very pale yellow, almost completely surrounded by the secretionary area. Form very irregular; the margin unevenly lobed, as is often the case with puparia formed upon hairy leaves. Length averaging rather less than 1 mm. Breadth about 0·50 mm.

Male puparium (*figs.* 4, 5) also colourless and transparent (a very unusual character in the genus); of the usual elongate form, with sub-parallel sides; obscurely carinate. Pellicle colourless, except at posterior extremity, where it is tinged with yellow. Length 0·75 mm.

Adult female pale yellow, with minute blackish eye-spots. At first elongate, broadest across mesothorax (*fig.* 11). After oviposition becoming greatly contracted and of irregular outline (*fig.* 12). Anterior spiracles with a small group of parastigmatic glands. Abdominal segments without marginal squames or pores. Pygidium (*fig.* 13) with a median longitudinal rounded ridge from anal orifice to extremity. Median and first lateral lobes projecting, but very minute and inconspicuous. Other lobes obsolete. Squames strongly developed, spiniform; one on each of first to fourth spaces, and a group of four to five on base, all of about equal size. Marginal pores on second, third, and fourth spaces, none on base. Dorsal series reduced to a single pore on fourth and basal spaces. Circumgenital glands in five groups: median 4 to 6; upper laterals 9 to 12; lower laterals 8. Anal considerably anterior to genital aperture. Length of extended insect averaging 0·40 mm.

Adult male (*fig.* 6) pale yellow. Wings rather narrow. Antenna (*fig.* 7) with long fine hairs, and a single knobbed hair at extremity. Foot (*fig.* 8) with three digitules, one ungual and two tarsal. Length (including genital sheath) 0·30 mm.

Eggs relatively very large, the long diameter being equal to breadth of the pygidium of the female (*fig.* 10).

Newly hatched larva (*fig.* 9) pale yellowish; rostrum approximately central; caudal setæ very long.

Habitat on under surface of leaves of *Tetranthera* sp. (*fig.* 1). Pundaluoya.

The scales occur in immense numbers on the leaves, but, from their minute size, are very inconspicuous. Their presence may be recognised by a yellowish discolouration of the leaf. This is by far the smallest species of *Chionaspis* at present known.

EXPLANATION OF PLATE XLI.

CHIONASPIS MINUTA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of leaf, with insects *in situ*, nat. size.
2. Female puparium.
3. „ „ containing eggs.
4. Male puparium, containing pupa.
5. „ „ empty.
6. Adult male, lateral view.
7. „ „ antenna.
8. „ „ leg.
9. Young larva.
10. Adult female, during oviposition.
11. „ „ dorsal view.
12. „ „ ventral view, after oviposition.
13. „ „ pygidium, ventral view.

CHIONASPIS PERMUTANS, *sp. nov.*

(Plate XLII.)

Female puparium (*figs.* 2, 5, 7) elongate, moderately dilated behind. Ventral scale incomplete, bordering the channel in which the insect lies. Colour pale ochreous, transparent, revealing the form and colour of the insect beneath. Pellicles of same colour. Total length 2·25 mm. Greatest breadth rather less than 1 mm.

Male puparium (*fig.* 12) snowy white, conspicuously tricarinate, the ridges uneven and undulating. Pellicle bright yellow.

Adult female elongate; at first with abdominal segments well marked and fully extended (*fig.* 4). Colour of early adult pale yellow. During gestation and after oviposition the terminal abdominal segments become retracted (*figs.* 6, 8), until finally the pygidium is concealed beneath the dorsal parts (*fig.* 7). In some examples the pygidium is entirely withdrawn into the body (*fig.* 3). I believe this part can be retracted or partially protruded at will. These changes in form are accompanied by equally complete change in colour and texture. The thoracic parts and the first abdominal segment become indurated and of a dark purple brown or blackish colour (*figs.* 3, 7). The terminal abdominal segments remain pale and flexible to the end. The pygidium is tinged with red. Lateral margins of second and third abdominal segments each with two to four spiniform squames. Parastigmatic glands small and inconspicuous. Pygidium (*fig.* 9) with moderately prominent lobes. Median pair shorter than first laterals, curved, diverging, finely serrate on inner margin. Second and third lobes duplex, bluntly pointed. In each of these duplex lobes it is noticeable that the mesal one only is accompanied by a thickened inward extension of the body wall. Squames small; one on each of first to fourth spaces, and two on base. The usual marginal pores. Dorsal pores irregularly distributed over the dorsal surface. Anal and genital apertures at same level. No circumgenital glands. Length of extended insect 1·50 to 1·62 mm.; after oviposition, 1·25 to 1·40 mm. Breadth 0·45 mm.

Adult male (*fig.* 10) minute; bright red, notal plates paler. Antenna about two thirds length of body; terminal joint with two knobbed hairs at side and one at apex (*fig.* 11). Foot with four digitules, the second ungual digitule on posterior feet sometimes consisting of a simple pointed hair. Genital sheath as long as abdomen. Total length 0·50 mm.

Young larvæ bright orange.

Habitat on under surface of leaves of *Antidesma bunius*. Pundaluoya. Also on unidentified shrub. Kandy.

The species is attacked by the minute hymenopterous parasite *Aphelinus mytilaspidis*, Le B.

To understand the development of this remarkable insect it must be studied in life. The difference between the early adult (*fig.* 4) and the final stage

(*fig.* 3) is so great that they might be mistaken for distinct species, or even genera. Such complete retraction of the pygidium is, I believe, a unique character.

There is a well-marked variety, also occurring on *Antidesma*, but never associated with the typical form. This variety—which may be distinguished as var. *verecunda*—occupies the small glandular pits at the base of the veins of the leaf, the anterior half of the insect being concealed within them. The female puparium and contained insects are usually contracted and considerably contorted by this habit.

EXPLANATION OF PLATE XLII.

CHIONASPIS PERMUTANS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Antidesma*, with insects, nat. size.
2. Female puparium, from above.
3. Adult female, after gestation, ventral view.
4. Early adult female, dorsal view.
5. Puparium of early adult female.
6. Adult female, transition stage, ventral view.
7. Female puparium, from below, with insect *in situ*.
8. Adult female, transition stage, dorsal view.
9. Pygidium of adult female.
10. Adult male, dorsal view.
11. „ „ terminal joint of antenna.
12. Male puparium.

CHIONASPIS HERBÆ, *Sp. nov.*

(PLATE XLIII.)

Female puparium silky white, or dull white. Second pellicle in some examples yellowish, in others reddish brown; always partially obscured by a thin layer of the white secretion. Moderately convex. Form varying in examples occurring on different species of grass. In specimens from *Panicum* the scale is dilated behind (*fig.* 3); in others from *Ischæmum ciliare* the scale is broad in front and distinctly narrowed behind (*fig.* 2). Intermediate forms occur on other grasses. The ventral scale is moderately well developed, and may either come away with the dorsal parts of the puparium (*fig.* 4), or remain attached to the plant, this difference depending upon the nature of the surface upon which the scale has been formed. Length 2 to 2·75 mm. Breadth 0·75 to 1·25 mm.

Male puparium (*fig.* 5) snowy white; of normal form; sides parallel; feebly tricarinate. Length 1·25 mm.

Adult female (*fig.* 6) bright yellow; older examples tinged with red. Metathorax and first abdominal segment (in fresh living examples) abruptly narrowed; lateral margin of second abdominal segment conspicuously produced (This character is not so noticeable in mounted specimens). Both pairs of spiracles with conspicuous parastigmatic glands. A scattered series of hair-like spines along the margin of the body. Second abdominal segment with from ten to twelve stout spiniform squames on each side, and third segment with four or five; both these segments with dorsal series of oval pores. Pygidium bluntly pointed or rounded. Lobes not very prominent; almost concealed above by irregularities of the margin (*fig.* 8); more conspicuous in younger examples and viewed from the under surface (*fig.* 9). Median lobes much broader than long, divergent, not serrate, bluntly pointed towards the outer edge. Second and third lobes duplex, the mesal lobule largest, each lobule bluntly pointed towards the inner edge. Squames spiniform: one or two on first and second spaces; one on third and fourth spaces; three or four on base. Conspicuous series of dorsal pores on third, fourth, and basal spaces, the inner series consisting of three or four pores close to the circumgenital glands. On the ventral surface are short series of much smaller oval pores, starting from the margin of second, third, and fourth spaces, and connected with small capitate ducts. There are also numerous small circular pores, with accompanying ducts, scattered over the general surface of the body, both dorsally and ventrally. The grandular scars on pygidium and penultimate segment very conspicuous. Circumgenital glands in five groups: median, 18 to 21; upper laterals, 33 to 47; lower laterals, 31 to 39. Anal slightly anterior to genital aperture. Length 1 to 1·50 mm. Breadth 0·50 to 0·75 mm.

Living females, removed from their scales, soon commence to secrete

filaments from both the squames and the oval pores. The former produce fine silky threads, and the latter appear to supply a cementing material in the form of golden coloured strap-shaped filaments (*fig.* 7).

Adult male bright red. Ocelli black. Rudimentary eyes on genæ (*fig.* 10) obscurely but unmistakably compound, surrounded by a ring of pigment spots. Antenna with single knobbed hair at apex. Foot with three digitules, one ungual and two tarsal. Length 0·60 mm.

Eggs numerous, bright yellow.

Habitat on stems and leaves of *Panicum* sp., *Ischæmum ciliare*, *Ophismenus compositus*, and various other grasses. Pundaluoya. A form with obscurely floriated median lobes occurs in Nuwara Eliya.

Allied to the American species, *Ch. pinifoliæ*.

EXPLANATION OF PLATE XLIII.

Chionaspis herbæ.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Grass stem (*Panicum* sp.) with insects *in situ*.
2. Female puparium, from *Ischæmum ciliare*.
3. „ „ from *Panicum* sp.
4. „ „ showing ventral scale.
5. Male puparium.
6. Adult female, dorsal view.
7. Margin of pygidium of living female, showing secretionary filaments.
8. Pygidium of female, dorsal view.
9. „ „ ventral view of extremity
10. Rudimentary eye of adult male.

CHIONASPIS POLYGONI, *sp. nov.*

(Plate XLIV.)

Female puparium white, more or less tinged with reddish brown (*fig.* 3) from adherent particles of the membranous stipules of the plant, beneath which the scales are often concealed. Sometimes the whole scale is covered in this manner (*fig.* 4). Secretionary area thin and transparent; usually dilated behind. Pellicles very pale straw colour. Ventral scale remaining attached to the plant as a delicate whitish film. Length 2 to 3 mm. Breadth about 1·50 mm.

Male puparium (*fig.* 2) of normal form; slightly widened behind. Carinæ smooth and not very prominent. Length 1·25 mm.

Adult female (*fig.* 5) at first yellow, deepening to reddish orange during gestation. Position of stigmata and circumgenital glands marked by white waxy patches. Median area (including meso- and metathorax and first two abdominal segments) broadest. Segments well defined. Both pairs of spiracles with parastigmatic glands. Second and third abdominal segments each with ten to twelve stout spiniform squames on margin. Pygidium (*fig.* 6) broad. Median lobes large and prominent, bluntly conical; inner edge sub-parallel at base, then widely divergent and minutely serrate; outer edge with small inconspicuous lobule. First and second lateral lobes duplex, of about equal size; both lobules bluntly pointed (*fig.* 6), or mesal lobule slightly dilated towards extremity (*fig.* 7). The pore-bearing prominence on second and third spaces strongly developed. Squames large and stout; one on each of first to fourth spaces, and five to seven on base. A series of conspicuous oval pores on each of fourth and basal spaces, and a similar series on third abdominal segment. Circumgenital glands in five groups; orifices numerous: median 12 to 19; upper laterals, 35 to 40; lower laterals, 27 to 35. Anal slightly anterior to genital aperture. Length averaging 1·25 mm. Greatest breadth about 0·75 mm.

Adult male bright red. Rudimentary eye-spot on genæ rather prominent. Foot with three digitules (one ungual, two tarsal). Terminal joint of antenna with a stout knobbed hair at apex as long as the joint, and a small sub-apical tubercle bearing two small spines. Genital sheath about one-third the length of the body. Total length 1·50 mm.

Eggs numerous, dull pale orange.

Habitat on stems on *Polygonum chinense.* Pundaluoya. At first concealed beneath the membranous stipules, but afterwards exposed by the extension of the stem during growth (*fig.* 1).

This species in many characters closely approaches the American insect *Ch. lintneri*; but Mr. W. A. Cooley, who is well acquainted with the latter species, and who is making a special study of the genus *Chionaspis*, assures me that they are quite distinct. *Ch. lintneri* may be distinguished by the presence

of a large number of oval pores on margins of abdominal and post-thoracic segments, which are wanting in the Ceylon insect. The large groups of stout spiniform squames are a noticeable feature in both species.

EXPLANATION OF PLATE XLIV.

CHIONASPIS POLYGONI.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Insects *in situ*, nat. size, on stem of *Polygonum*.
2. Male puparium.
3. Female puparium.
4. " "
5. Adult female, dorsal view.
6. Pygidium of female, dorsal view.
7. " " " showing variation in lateral lobes.

CHIONASPIS ACUMINATA, *Green.*

(PLATE XLV.)

Chionaspis acuminata, Green, 'Catalogue of Coccidæ,' *Indian Museum Notes*, Vol. IV., No. 1, p. 3 (1896).

Female puparium (*fig.* 7) elongate, narrow, pointed in front, and gradually widening to posterior extremity; a well-defined median longitudinal ridge along the entire length; margin flattened. Colour pale brownish fulvous, sometimes dark brown. Pellicles pale yellow. Ventral scale consisting of a narrow strip on each side, attached within the flattened margin, and bordering the channel in which the insect lies. Length 2·50 to 3 mm. Greatest breadth 1 mm.

Male puparium (*figs.* 2, 3) elongate; sides parallel; strongly tricarinate, the carinæ very rugose, the median one broad and prominent. Pellicle yellow, usually masked by a little tuft of woolly matter. Secretionary area white, tinged with red in the furrows, and a narrow line of same colour on each side of median carina. This colouration—a very unusual character—is not dependent upon the presence of the contained insect, but persists after the exit of the adult male. The puparia are massed in large clusters, and so arranged that they lie parallel with each other, all pointing in the same direction. The coloured lines give a pinkish tinge to the whole mass, unlike the snowy white appearance of most other species. Length 1·30 mm. Breadth 0·50 mm.

Adult female (*figs.* 8, 9) long and narrow, sides sub-parallel, slightly wider behind. Abdominal segments well defined. During gestation the abdomen contracts, while the thoracic segments (especially the mesothorax) increase in length. Colour bright yellow, tinged with orange in older examples, two small marginal tubercles near anterior extremity marking position of rudimentary eyes. Antenna consisting of the usual tubercle and stout curved bristle. Anterior spiracles with small group of parastigmatic glands. Abdominal segments with marginal groups of small but stout spiniform squames. Pygidium (*fig.* 10) with small but distinct lobes; the first and second pairs duplex; median lobes and each lateral lobule wedge-shaped, contracted at base, outwardly oblique. Squames stout; one on each of third and fourth spaces and two on base. The usual squames on first and second spaces appear to be obsolete. Oval pores distributed over the entire dorsal surface of pygidium, and a few on the penultimate segment. Orifices of circumgenital glands few: median, 4; upper laterals, 6 to 7; lower laterals, 4 to 5. Anal and genital apertures at same level. Length averaging 1·50 mm. Greatest breadth 0·50 mm.

Adult male (*fig.* 4) bright reddish orange; legs and extremity of antennæ very pale straw colour. Terminal joint of antenna (*fig.* 6) with two fine knobbed hairs at side and a stouter one at apex. Foot (*fig.* 5) with three digitules (one ungual, two tarsal); tarsus as long as tibia.

Eggs orange yellow.

Young larvæ pale yellow.

Habitat on leaves of *Ardisia sp.* and another unidentified shrub. Punda-luoya. The female scales occur on both surfaces of the leaves, while the male scales are clustered on the under surface only.

A form collected in Kandy has the female puparium dark chocolate brown. The median lobes of pygidium are rather smaller and shorter than in typical examples, and more distinctly serrate on their free edge.

EXPLANATION OF PLATE XLV.

CHIONASPIS ACUMINATA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf with insects *in situ*, nat. size.
2. Male puparium, dorsal view.
3. „ „ side view.
4. Adult male.
5. „ „ foot.
6. „ „ terminal joint of antenna.
7. Female puparium, dorsal view.
8. Adult female, ventral view.
9. „ „ older example, dorsal view.
10. „ „ pygidium.

CHIONASPIS ELÆAGNI, *Green.*

(PLATE XLVI.)

Chionaspis elæagni, Green, 'Catalogue of Coccidæ, *Indian Museum Notes*, Vol. IV., No. 1, p. 3 (1896).

Female puparium (*fig.* 4) very slightly convex; irregular in outline, but usually more or less broadly pyriform; very thin and delicate. Colour greyish white, semi-transparent; pellicles very pale straw colour. The first pellicle only exposed; rest of scale completely covered with the stellate hairs of the leaf, which remain in their original position, the scale being gradually extended beneath them. Length about 3 mm. Greatest breadth 2 mm.

Male puparium (*fig.* 5) of normal form; sides almost parallel; strongly tricarinate; snowy white, pellicle pale straw colour. Length 1 mm.

Adult female bright yellow; terminal segment reddish (*fig.* 3), but frequently masked by a layer of white waxy matter (*fig.* 6); rostral area brownish. Form oblong; thoracic segments broadest; abdominal segments at first well defined (*fig.* 6), contracting after oviposition, when the insect becomes almost rhombic in outline (*fig.* 3). Eyes wanting, but their normal position marked by minute marginal tubercles. Antenna (*fig.* 11) consisting of a small tubercle and stout curved bristle. Second and third abdominal segments fringed with spiniform squames. Pygidium (*fig.* 7) pointed. Lobes large and prominent; median pair largest and divergent; first and second lateral lobes duplex, each lobule wedge-shaped; all the lobes minutely crenulate on their free edges. A single pointed squame on each of first to fourth spaces, and two or three on base. Marginal pores normal. A series of oval pores on each of fourth and basal spaces, and a similar series on third abdominal segment. In some examples, especially such as have been parasitised, the squames are more or less suppressed. Circumgenital glands in five groups: median, 8 to 18; upper laterals, 15 to 20; lower laterals, 8 to 18. Anal slightly below genital aperture. Size very variable. Length 1·25 to 2·30 mm. Breadth 0·40 to 1 mm.

Adult male (*fig.* 8) bright red or reddish yellow, scutellum paler, lateral margin of abdomen purplish, tarsi pale. Form normal, moderately stout. Upper pair of ocelli smallest; lower pair separate by less than half their diameter. Antenna as long as body; hairy; terminal joint abruptly narrowed in front, a curved knobbed hair at apex (*fig.* 9). Foot (*fig.* 10) with three knobbed hairs, one on claw and two on tarsus. Genital sheath long and slender, more than half length of body. Total length of insect 0·75 mm.

Eggs and young larvæ bright yellow. Eggs very numerous.

Habitat on under surface of leaves of *Elæagnus latifolia;* Pundaluoya. The male scales occur in large groups; the female scales singly (*fig.* 1).

A fairly abundant species, but escaping notice by reason of its protective

covering. But, though such an inconspicuous species, it seems to be almost more extensively parasitised than any other. Fully ninety per cent. of the specimens examined contained pupæ of hymenopterous parasites. Such specimens assume an elongate form (*fig.* 2), all the segments well defined, the parasite occupying the thoracic region. The parasite has been named by Dr. L. O. Howard *Physcus varicornis.*

EXPLANATION OF PLATE XLVI.

CHIONASPIS ELÆAGNI.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Elæagnus*, with insects *in situ*, nat. size.
2. Adult female, containing pupa of parasite.
3. „ „ after oviposition, dorsal view.
4. Female puparium.
5. Male „
6. Adult female, before oviposition, ventral view.
7. „ „ pygidium.
8. Adult male, dorsal view.
9. „ „ terminal joint of antenna.
10. „ „ foot.
11. Rudimentary antenna of female.

CHIONASPIS VITIS, *Green.*

(PLATE XLVII.)

Chionaspis vitis, Green, 'Catalogue of Coccidæ,' *Ind. Mus. Notes*, Vol. IV., No. 1, p. 3 (1896).

Female puparium (*fig.* 3) white, thin, and semi-transparent; occupied scales indistinctly showing the colour of the insect and eggs beneath (*fig.* 2). Pellicles pale fulvous, the first very small, usually only one-third length of second. Secretionary area very irregular in outline, usually broadly rounded or deltoid, breadth about equal to length, rarely elongate. Length 2·50 mm. Breadth 2·50 mm.

Male puparium (*fig.* 9) snowy white; elongate, narrow; distinctly tricarinate, the carinæ smooth and regular; sides almost parallel, the hinder extremity slightly wider. Pellicle about one-fifth total length of scale. Length 1 mm.

Figs. 7, 8, and 9 represent different stages in the development of the male scale. A median dorsal and a lateral line of waxy matter first appear on the body of the insect, after the first moult (*fig.* 7). These coalesce by lateral growth (*fig.* 8), the subsequent extension being entirely longitudinal.

Adult female at first bright yellow (*fig.* 4); afterwards the median area of the body becomes deeply tinged with reddish brown by the accumulation of ova within the body (*fig.* 5), the form of each individual egg being plainly visible. Eye-spots blackish, well defined and conspicuous, situated on prominent marginal papillæ. Body broadest across mesothorax. Abdominal segments distinct and deeply divided, the margins with groups of pores and very small tubular processes (*fig.* 6). Antenna consisting of the usual tubercle and stout curved bristle. Mouth parts rather large. Anterior spiracles with a small but crowded group of parastigmatic glands. Pygidium (*fig.* 6) with small but distinct median and lateral lobes, all crowded upon the extremity; median lobes diverging, bluntly pointed; the two lateral lobes duplex, each lobule bluntly pointed. Squames rather small, especially near the extremity; one on each of first to fourth spaces, and four or five on base. Marginal pores normal. Dorsal series consisting of a single oval pore on third space, an interrupted series on fourth and basal spaces, and a series on third abdominal segment. Circumgenital glands in five groups: median 15 to 25; upper laterals 18 to 37; lower laterals 14 to 22; the upper lateral groups always largest. Anal at same level as or slightly below genital aperture. Length of fully extended example 1·25 mm. Greatest breadth about 0·82 mm.

Adult male (*fig.* 10) bright reddish orange, legs pale. Ocelli large and black. A distinct blackish spot on genæ, representing the rudimentary eye. Antenna not quite as long as body; terminal joint as long as penultimate; a single knobbed hair at apex, and a small sub-apical tubercle bearing two small bristles (*fig.* 13). Foot (*fig.* 11) with three digitules (one ungual projecting beyond

extremity of claw, and two tarsal not reaching extremity of claw). Length 0·75 mm.

Newly hatched larva (*fig.* 12) pinkish, tinged with orange.

Eggs usually reddish; occasionally orange yellow.

Habitat on *Vitis lanceolaria* and allied species; usually upon the under surface of the leaves, though a few individuals find their way on to the upper surface. Found also rarely upon the upper surface of leaves of *Elæagnus latifolia*, also more commonly on leaves of *Loranthus sp.* Pundaluoya, Nuwara Eliya. The insects always occur in large colonies, and cause conspicuous discoloured spots and blotches upon the leaves. Should the grape-vine be ever cultivated largely in Ceylon, this insect might prove a rather serious pest.

EXPLANATION OF PLATE XLVII.

CHIONASPIS VITIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Vitis sp.*, with insects, nat. size.
2. Female puparium, occupied by insect and eggs.
3. " " empty.
4. Adult female, before gestation, ventral view.
5. " " containing ova, dorsal view.
6. " " pygidium.
7, 8, 9. Stages in growth of male puparium.
10. Adult male, dorsal view.
11. " " foot.
12. Young larva.
13. Terminal joint of antenna of male.

CHIONASPIS HEDYOTIDIS, *sp. nov.*

(Plate XLVIII.)

Female puparium (*fig.* 2) white; thin and semi-transparent, faintly revealing the form and colour of the insect beneath. Form oblong, narrow in front, widened and irregularly rounded behind; margin often indented owing to the interference of the hairs of the plant. Examples occurring on upper surface of leaves and on exposed parts of the stem have the puparium of a stouter texture. Ventral scale scarcely perceptible as a delicate film remaining attached to the plant. Pellicles pale and transparent, except in specimens on exposed parts, when they are brighter coloured and more opaque. Length 2 to 2·75 mm. Breadth 1 to 1·12 mm.

Male puparium (*fig.* 3) white, thin, the reddish colour of the pupa showing indistinctly through the scale; tricarinate, the carinæ smooth and not very prominent. Pellicle yellow. Length nearly 1·50 mm.

Adult female elongate; abdomen as broad as or broader than thorax. Colour, yellow in examples from under surface of leaf, bright orange in those from exposed parts. Very faint eye-spots can be distinguished in the living insect, on minute marginal prominences. A scattered marginal series of minute hair-like spines all round the body. Parastigmatic glands at each spiracle. Rudimentary antennæ more than usually conspicuous; the basal disc well defined, bearing a stout curved bristle and several small prominences. A group of seven to ten stout conical squames and a marginal series of small pores on second and third abdominal segments. Pygidium (*fig.* 7) with median lobes slightly divergent, bluntly pointed or rounded: lateral lobes duplex, each lobule with rounded extremity. Squames moderately large; one on each of first and fourth spaces, and three or four on base. (In a form from Nuwara Eliya there are two to three squames on the fourth space, and five to seven on base.) A single dorsal pore on third space, a small series on fourth space, and rather larger series on the base and on the third abdominal segment. Circumgenital glands in five groups: median, 14 to 16; upper laterals, 22 to 28; lower laterals, 15 to 20. In one example an extra group of glands (with seventeen orifices) appears outside the upper laterals on one side, taking the place of the glandular scar usually found in this situation. Anal and genital apertures usually at same level, the former sometimes slightly anterior. Length 0·75 to 1 mm. Breadth 0·50 mm.

Adult male bright red; legs and antennæ yellowish. Rudimentary eyes on genæ colourless. Terminal joint of antenna (*fig.* 4) shorter than ninth, with a single knobbed hair at apex as long as or longer than the joint, and a sub-apical tubercle with two short spines. Foot with three digitules (one ungual and two tarsal). Total length 1·75 mm., including genital sheath, which measures 0·50 mm.

Eggs, yellow to bright orange.

Habitat on *Hedyotis auricularia* and other allied species. Scales irregularly distributed, mostly on under surface of leaves. Pundaluoya. Specimens of *Hedyotis Lawsoniæ* have been received from Nuwara Eliya, badly infested with this insect. The stems and leaves of the plant are quite white from the multitude of scales. If it should ever attack cultivated plants to the same extent, this insect would prove a most serious pest.

Differs from *Ch. vitis* in the form of the puparium and female insect. Closely allied also to *Ch. litzeæ*, from which it may be distinguished by the more prominent median lobes.

EXPLANATION OF PLATE XLVIII.

CHIONASPIS HEDYOTIDIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of *Hedyotis auricularia*, with insects, nat. size.
2. Female puparium.
3. Male puparium.
4. Terminal joint of male antenna.
5. Adult female, dorsal view.
6. „ „ pygidium, dorsal view.

CHIONASPIS LITZEÆ, *sp. nov.*

(PLATE XLIX.)

Chionaspis eugeniæ, var *litzeæ*, Green, 'Catalogue of Coccidæ,' *Ind. Mus. Notes*, Vol. IV., No. 1, p. 2 (1896).

Female puparium oblong oval, one side usually straight (*fig.* 2), where it has been confined by one of the prominent veins of the leaf; broadest across median area. White; very thin and delicate; semi-transparent. Pellicles very pale straw colour. Secretionary area completely surrounding the second pellicle. Length 2 to 2·50 mm. Breadth 1·25 to 1·50 mm.

Male puparium (*fig.* 3) snowy white; elongate, narrow, sides almost parallel; strongly and distinctly tricarinate, the carinæ slightly sinuous; the secretionary area overlapping the hinder half of the pale yellow pellicle. Length 1·25 mm.

Adult female (*fig.* 4) bright pale yellow, scarcely darkening in older examples. Eye-spots conspicuous, blackish, situated on small marginal prominences. Form oblong, broadest across mesothorax, tapering behind. Abdominal segments well defined before oviposition, their lateral margins protuberant. Anterior spiracles with small and inconspicuous parastigmatic glands. Margins of second and third abdominal segments with many small pores and conical squames. Pygidium (*fig.* 5) with median lobes moderately large, sunk in median cleft, divergent, their free edges quite smooth. Second and third pairs of lobes rather smooth, scarcely projecting beyond margin, not narrowed at base, duplex, the mesal lobule in each case larger and truncate, the lateral lobule bluntly pointed. Squames spiniform, those nearest the extremity very small; one on each on first to fourth spaces, and two or three on base. Dorsal pores few; usually one on each of third and fourth spaces, a series on base, and a larger series on third abdominal segment. Circumgenital glands in five groups; median 16 (this number of orifices constant in every individual of a large series examined); upper laterals 25 to 33; lower laterals 16 to 23. Anal slightly posterior to genital aperture. Length of extended example 1·25 mm. Greatest breadth 0·60 mm.

Adult male bright red. Antenna with sparse whip-like hairs; terminal joint (*fig.* 6) shorter than penultimate; a very slender minutely knobbed hair at apex. Foot (*fig.* 7) with three digitules, one on claw and two on tarsus, all very slender and with very minute knobs. Claw long and slender, nearly half length of tarsus; tarsus shorter than tibia. Length (including genital sheath) 1 mm.

Eggs and young larvæ bright yellow.

Habitat on leaves of *Litzea zeylanica*. Pundaluoya; Nuwara Eliya. Usually on under surface of leaves; but occasionally occurring on upper surface also.

This species, at first considered to be a variety of *Ch. eugeniæ*, Mask.

proves upon closer examination to be quite distinct. Though placed in a separate section, on account of the distinct median cleft, this insect is really very closely allied to both *vitis* and *hedyotidis.* It may be readily distinguished by the deep median cleft, containing the median lobes. Other small differences can be best appreciated by reference to the figures.

EXPLANATION OF PLATE XLIX.

CHIONASPIS LITZEÆ.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Litzea zeylanica*, with insects, nat. size.
2. Female puparium.
3. Male puparium.
4. Adult female, before oviposition, dorsal view.
5. ,, ,, pygidium, dorsal view.
6. Terminal joint of antenna of adult male.
7. Foot of male.

CHIONASPIS VARICOSA, *sp. nov.*

(PLATE L.)

Chionaspis eugeniæ, var. *varicosa*, Green, 'Catalogue of Coccidæ,' *Indian Museum Notes*, Vol. IV., No. 1, p. 2 (1896).

Female puparium (*fig.* 2) snowy white, opaque, of rather stout texture; very broadly and roundly dilated, so that the width usually equals the length; flattish, with the surface veined with irregular raised lines. Secretionary area often completely surrounding the second pellicle. Pellicles pale fulvous, the second tinged with red. Length 3 mm. Breadth 3 mm. Length of second pellicle 1 mm.

Male puparium white, pellicle very pale yellow. Oblong, narrow; carinæ very feebly indicated (*fig.* 4); surface often coated with fibrous secretion (*fig.* 3). Length 1·75 mm.

Adult female (*figs.* 5, 6, 7) pale yellow, pygidium reddish. Form oblong; broadest across mesothorax; segments rather protuberant. In the living insect very faint rudiments of eye-spots can be seen. Anterior spiracles with conspicuous parastigmatic glands. Margin of meso and metathorax and all three abdominal segments with groups of small conical squames intermixed with oval pores. Pygidium (*fig.* 8) with a broad and deep median cleft containing the rather large divergent median lobes, their free edges minutely serrate. Second and third lobes well developed, duplex, each lobule very prominent, with rounded extremity and constricted base, projecting considerably beyond the margin. Squames spiniform; one on each of first to third spaces, usually three on fourth space, and a group of four to seven on base. Dorsal pores numerous: a group of two or three on third space, large series on fourth and basal spaces, and still larger, often double, series on second and third abdominal segments. Circumgenital glands in five groups; orifices numerous; median group 10 to 16; upper laterals 23 to 27; lower laterals 27 to 60; the lower groups always the larger. Anal anterior to genital aperture. Length 1·50 to 2 mm. Breadth 0·75 mm.

Adult male bright reddish orange. Form normal. Terminal joint of antenna with knobbed hair at apex (*fig.* 9). Tarsus a little shorter than tibia. Foot (*fig.* 10) with three digitules, one ungual and two tarsal. Length including genital sheath 1 mm.

Eggs and young larvæ yellow.

Habitat on the under surface of leaves of *Gelonium lanceolatum*. Pundaluoya. The female scales are usually placed close to the mid rib or veins. The males are clustered on the interspaces between the veins (*fig.* 1).

Mr. Maskell considered this to be a variety of his *Ch. eugeniæ*, but examination of an extensive series of specimens inclines me to believe that the species is distinct. In typical *eugeniæ* the pygidium is broader and rounder, the median

lobes smaller and more divergent, the first lateral lobes less prominent, and the second lateral lobes obsolete.

EXPLANATION OF PLATE L.

CHIONASPIS VARICOSA.

(*All figures, except No.* 1, *more or less enlarged.*

Fig. 1. Part of leaf of *Gelonium*, with insects, nat. size.
2. Female puparium.
3. Male ,,
4. ,, with fibrous covering removed.
5, 6. Adult female, dorsal view.
7. ,, ,, ventral view.
8. ,, ,, pygidium.
9. Terminal joint of antenna of male.
10. Foot of male.

CHIONASPIS DILATATA, *sp. nov.*

(PLATE LI.)

Female puparium (*fig.* 2) very similar to that of *varicosa*, usually with the same vein-like surface markings (examples from 'Nutmeg' and 'Mango' smoother). Second pellicle more opaque and of a deeper reddish brown colour. The whole puparium and its component parts smaller than in *varicosa*. Length 2 mm. Breadth 1·50 mm. Length of 2nd pellicle 0·65 mm.

Male puparium (*fig.* 3) feebly keeled. Length 1 mm.

Adult female (*fig.* 4) of same form and colour as *varicosa*. Margin of mesothorax without squames, and two or three only on metathorax. Pygidium (*fig.* 5) with the first lateral lobes smaller and less prominent; second lateral lobes obsolete. Marginal squames fewer; one on each of first to third spaces; one or two on fourth space; and two or three on base. Dorsal pores also less numerous; present on the same number of segments. Circumgenital glands smaller; median group 4 to 8; upper laterals 9 to 16; lower laterals 11 to 18. Length 0·75 to 1 mm. Breadth averaging 0·50 mm.

Adult male not observed.

Habitat on *Eurycles* sp. *Myristica moschata* (nutmeg), and *M. laurifolia;* Kandy. Also on 'Mango;' Pundaluoya. Upon *Eurycles* the female scales are distributed over both surfaces of the leaf, the males being confined to the under surface. Upon *Myristica* and 'Mango' both sexes were observed on the under surface only of the leaves.

Altogether a smaller form than the preceding (*varicosa*), and distinguished from it by the absence of the second pair of lateral lobes, and by the smaller number of orifices in the circumgenital glands.

EXPLANATION OF PLATE LI.

CHIONASPIS DILATATA.

(*All figures except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of leaf of *Eurycles*, with insects, nat. size.
2. Female puparium.
3. Male puparium.
4. Adult female, ventral view.
5. „ „ pygidium, dorsal view.

CHIONASPIS MEGALOBA, *sp. nov.*

(Plate LII.)

Female puparium (*fig.* 3) whitish or very pale ochreous; semi-opaque; the surface with numerous hairs detached from the leaf. Pellicles pale yellow. Moderately convex. Form oblong, widened and rounded behind. Ventral scale very thin, remaining adherent to the leaf. Length 1·25 mm. Breadth 0·80 mm.

Male puparium (*fig.* 2) opaque white; conspicuously tricarinate; rather broad, widened behind. Length 1 mm. Breadth 0·50 mm.

Adult female (*fig.* 4) abruptly narrowed in front, broadly rounded behind: abdominal segments broadest. Colour of dried insect brownish; living insect probably yellow. Spiracles each with a small group of parastigmatic glands. Second and third abdominal segments with a few spiniform squames on margin. Pygidium (*fig.* 5) broad, deeply incised at extremity; the sides of the cleft occupied by the very large and conspicuous median lobes, their bases united, their free edges minutely serrate, their distal extremity scarcely projecting beyond the margin. Second and third lobes minute, duplex, each lobule with simple rounded extremity. Squames rather stout; one on each of first to fourth spaces (that on first space very small), and a group of three on base. The marginal dorsal spines are unusually large and conspicuous, being almost as long as the squames. Dorsal pores well developed; a series on each of third, fourth, and basal spaces, and another on third abdominal segment. (In examples from *Actinodaphne* there are no dorsal pores on the third space.) Circumgenital glands with numerous orifices: median, 12 to 16; upper laterals, 28 to 34; lower laterals, 18 to 24. Anal anterior to genital aperture. Length 0·50 to 0·60 mm. Breadth about 0·40 mm.

Adult male unknown.

Habitat on leaves of *Psidium* (?) sp. Collected by Mr. A. Kœbele at Kandy (January). I have also taken examples of what appears to be the same species on plants of *Actinodaphne molochina* growing on the summit of Pedrotalagala, Nuwara Eliya, at an elevation of over 8000 feet.

EXPLANATION OF PLATE LII.

Chionaspis megaloba.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf, with insects *in situ*, nat. size.
2. Male puparium.
3. Female puparium.
4. Adult female.
5. " " pygidium.

CHIONASPIS FLAVA, *sp. nov.*

(PLATE LIII.)

Female puparium (*figs.* 2, 6, 7) pointed in front, roundly dilated behind; surface marked with irregular raised lines. Colour, in fresh specimens, bright canary yellow (*fig.* 6); in older examples, brownish ochreous (*fig.* 2). Pellicles yellowish; the median area of the second pellicle thin and transparent. Ventral scale rather strongly developed, and persistent towards the margins, where it forms a ragged fringe partially enveloping the insect (*fig.* 7). Length 3 mm. Breadth 1·75 mm.

Male puparium snowy white (*fig.* 3); pellicle yellowish. Form normal; sides sub-parallel; strongly tricarinate, the carinæ rugose. Length slightly over 1 mm.

Adult female bright pale yellow, pygidium reddish. Narrowed in front; broadest across metathorax and base of abdomen. Segments at first distinct, and laterally protuberant (*fig.* 5). In older examples the divisions of all but the terminal segments are obliterated, and the dorsal parts (including cephalo thorax and anterior half of first abdominal segment) become smooth and indurated (*fig.* 4). In macerated examples this chitinous area appears of a darker tint (*fig.* 8). Antenna (*fig.* 10) with two short curved bristles on a conicle tubercle. Anterior spiracles with a small group of parastigmatic glands. Lateral margins of all three abdominal segments with large groups of stout spiniform squames. Pygidium (*fig.* 9) with a deep median cleft containing the median lobes, which are elongate, diverging and serrate on the free edge. Second and third lobes prominent, duplex, each lobule constricted at base. Squames spiniform, one on each of first to fourth spaces and two on base. No circumgenital glands. Dorsal pores numerous and conspicuous, arranged in irregular series over the second, third, fourth, and basal spaces. An interrupted series on the third abdominal segment, and a few pores on the second. Anal and genital apertures at same level. Length 2 mm. Breadth 1 mm.

Adult male bright red; of usual form. Terminal joint of antenna with two very fine knobbed hairs on one side and a stouter one at apex. Foot with four digitules. Total length, including genital sheath, 0·75 mm.

The young larvæ discard the egg skin at the time of their extrusion from the body of the parent insect.

Habitat upon under surface of leaves of *Antidesma bunius;* Pudaluoya. The male puparia are collected into large groups. The position of the insect is marked by a yellow discolouration of the tissues of the leaf.

This species approaches *Ch. citri*, Comst., in the hardening of the anterior parts of the body, and in the absence of the circumgenital glands, but differs in the character of the median lobes, those of *citri* being prominent.

It is remarkable that both of the two species of *Chionaspis*, viz., *permutans* and *flava*, affecting *Antidesma*, have this characteristic induration of the

thoracic parts. There also appears to be some correlation between the excessive deposition of chitin and the absence of circumgenital glands, *e.g.*, *Aspidiotus aurantii*, *Chionaspis citri*, *Ch. permutans*, *Ch. flava*, *Ch. biclavis*; probably others could be added to the list.

EXPLANATION OF PLATE LIII.

CHIONASPIS FLAVA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Antidesma*, with insects *in situ*, nat. size.
2. Female puparium, old scale.
3. Male puparium.
4. Adult female, after gestation.
5. „ „ before gestation.
6. Female puparium, early adult scale.
7. „ „ from below.
8. Adult female, ventral view.
9. „ „ pygidium, dorsal view.
10. „ „ antenna.

CHIONASPIS BICLAVIS, *Comstock.*

(Plate LIV.)

Chionaspis biclavis, Comst., *Second Report on Scale Insects*, 1893, p. 98.

Howardia biclavis, Berlese and Leonardi, *Rivista di Patalogia Vegetale*, Anno IV., Num. 7–12, p. 348.

Aspidiotus theæ (part), Green, 'Insect Pests of the Tea Plant,' p. 12.

Female puparium (*figs.* 3, 4) broadly oval, slightly narrower behind, often almost circular; convex above. The actual colour of the scale is greyish; but it is rendered very inconspicuous, and made to harmonise with its surroundings by the incorporation of the superficial fibres and scaly particles of the bark, the natural position and arrangement of these particles being undisturbed (*fig.* 2). The concealment is so complete that the scales appear only as slight inequalities or minute blisters on the stem of the plant (*fig.* 1). But, where a dead scale has been displaced or fallen off, a conspicuous whitish scar is visible. This habit has earned for it, in America, the name of the 'mining scale.' It does not, however, penetrate beneath the living cuticle of the plant, but, like many of its congeners, insinuates itself beneath the loose outer dead layers of the bark. Frequently the outer covering matter of the scale becomes abraded, revealing the greyish white material of the secretionary area. This form resembles that described by Mr. Maskell as var. *detecta*. When the scale is formed upon a smooth-stemmed plant, the surface is usually coated with a layer of reddish brown varnish-like material, to match its surroundings. Ventral scale white, moderately stout, remaining adherent to the bark, except around the margin, where it often comes away with the dorsal parts. First pellicle minute and inconspicuous, projecting from the anterior margin of the puparium. Second pellicle completely concealed. Length 2·50 mm. Breadth 2 mm.

Male puparium unknown. Although the females are extremely abundant, not a single male insect has been observed either in Ceylon or elsewhere. It must therefore be supposed that the young are produced asexually.

Adult female (*figs.* 5, 8), broadly ovoid; broadest across mesothorax; rounded in front, bluntly pointed behind; division of segments distinct. Colour varying with age; at first creamy white (*fig.* 5); median dorsal area afterwards suffused with pinkish purple; later, with chestnut brown, by the deposition of chitinous matter, which first appears in definite transverse plates across the meso and metathorax and first two abdominal segments (*fig.* 6), but afterwards extends over the whole dorsal surface as far as the second abdominal segment (*fig.* 7). Under surface of older examples dull purplish; the second and third abdominal segments and base of pygidium whitish. Inconspicuous eye-spots can be distinguished in the early adult (*fig.* 5). Antenna with four to six stout spines on a thickened disc (*fig.* 10). Both pairs of spiracles with parastigmatic glands. Second and third abdominal segments each with a marginal group of

from six to eight stout tapering squames. Pygidium (*fig.* 9) with the basal space more distinct than in most species, its lateral margins strongly protuberant. Median lobes large, prominent, and conspicuous; conical, the apex nearest the inner edge; outer edge minutely serrate; extremity produced into a rounded lobule. First lateral lobe very small and inconspicuous, simple, bluntly pointed. Other lobes obsolete, or represented by small marginal prominences. Squames tapering, spiniform, large and stout at base of pygidium, but decreasing towards the extremity; two on mesal and first lateral spaces, three on second space, three to four on third space, four to five on fourth space, and about six on base. A conspicuous pair of stout club-shaped organs project inwards from the margin of the mesal space. Dorsal pores small and circular with thickened rims; three or four close to margin of first lateral space; extended series on second and third spaces; three or four series on fourth space; and scattered pores on the base. A few similar pores occur on the ventral surface, together with some minute scattered spines. No circumgenital glands. Anal slightly anterior to genital aperture. Length 2 mm. Breadth 1·60 mm.

Adult male unknown.

The insect is ovoviviparous, as indicated by the absence of circumgenital glands. The fully formed larvæ can be seen within the body of the parent.

Young larvæ comparatively large, 0·80 mm. long. Even at this early stage parastigmatic glands (each with two orifices) are present at the anterior spiracles. The extremity of the abdomen (*fig.* 11) bears a pair of large and conspicuous triangular lobes, between which are the whip-like caudal setæ and two very minute divergent lobes. Rostral loop very long.

Habitat on the stems and branches of cinchona and tea plants, rarely on coffee. Also on *Flacourtia* sp., *Microglossa zeylanica*, and several unidentified plants. In America it is said to occur upon leaves. In Ceylon I have observed it only on the stems of plants. A very common and generally distributed species in Ceylon. It has been collected by Mr. Kœbele in the Sandwich Isles; and specimens have been found in conservatories in Ireland.

This species occurs in distinctly injurious numbers upon cinchona and tea; in the latter case it is responsible for many unhealthy hide-bound bushes. The insect is rendered so inconspicuous by the nature of its scale that its presence is very generally overlooked. Often the only outward indication of the pest is the roughened, 'pimply' condition of the bark. On passing the back of a pruning knife down an affected stem, many of the scales will be dislodged, leaving a small circular scar marking their former position. A purplish juice exudes from the crushed insects. The covering scale is so stout and impervious to liquids that ordinary insecticides fail to reach the actual insect. It has even been found to resist the action of hydrocyanic acid gas—a most deadly poison. Kerosene emulsions or other soap washes, applied with a brush to the stems, would destroy the young insects and help to keep the pest in check. Perhaps the most efficacious plan is to scrub the affected stems with a pad made of coir yarn or cocoa-nut matting, which will dislodge the scales and crush the insects. This treatment has the further advantage of removing accumulations of lichen and moss, which particularly affect such hide-bound trees.

Drs. Berlese and Leonardi have erected a new genus (Howardia) to contain this species, the distinguishing character being the absence of the circumgenital

glands. Although I think that the general characters of the insect are such as would warrant its separation from Chionaspis—should other closely allied forms be discovered—I have for the present retained it in its original genus.

EXPLANATION OF PLATE LIV.

CHIONASPIS BICLAVIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of cinchona stem, with insects *in situ*, nat. size.
2. Piece of bark from tea stem, enlarged, showing two scales.
3. Female puparium, from above.
4. " " from below.
5. Early adult female, dorsal view.
6. Later stage " " "
7. Adult female, fully developed, dorsal view.
8. " " " " ventral "
9. " " pygidium, dorsal view.
10. " " antenna.
11. Abdominal extremity of young larva.

CHIONASPIS FODIENS, *sp. nov.*

(PLATE LV.)

The female insect does not construct any puparium, but imbeds itself in the tissues of the bark (*fig.* 1) and leaves (*fig.* 8) of a species of *Loranthus* without forming any definite cell (*figs.* 2, 15). The position of the insect is marked by a small wart-like swelling on the surface, with a central depression and perforation which, in fresh examples, is closed by the first pellicle (*fig.* 9). In older examples the pellicle is usually absent, displaced probably either by the entrance of the male or the exit of the young larvæ. The female insect lies in a curved position, with the posterior extremity usually, but not always, directed towards and close to the orifice of the gall. Second pellicle very thin and delicate, closely investing the early adult as in *Fiorinia* (*fig.* 12), but becoming ruptured and discarded during subsequent growth. The inclusion of the insect within the substance of the plant cannot be entirely due to the overgrowth of the surrounding tissues, as it penetrates the underlying parts. The entrance must be effected during the second stage, the larval skin always remaining on the surface ; but the means employed by a soft-bodied insect, without limbs or biting mouth-parts, remain a mystery. It can scarcely be mechanical. Possibly chemical action is made use of in the form of some corrosive secretion.

A single male puparium (untenanted), presumably of this species, was found on one of the leaves. It was placed in a crevice, where the leaf had been partially broken. It was of normal form (*fig.* 10), snowy white, indistinctly tricarinate, the secretionary area rather short.

Adult female bright orange (*fig.* 15), deepening to orange red in older examples (*fig.* 2); extremity of pygidium dark brown. 'Comma' shaped, the thoracic parts twisted round and bent at right angles to the abdominal parts (*figs.* 3, 4, 5), the concavity representing the ventral area. The dorsal area in fully matured examples bears an irregular dark-coloured crest (*fig.* 4), and on one side of the body are raised lines enclosing a figure-of-eight-shaped space (*fig.* 5). The whole body is so distorted that it is difficult to determine the true position of the parts. The pygidium is occasionally partly retracted into the preceding segments.

An examination of the early adult immediately after ecdysis shows it to be of more normal form (*fig.* 11). In this early stage the cephalo-thorax occupies only about one-third of the entire length. It is during subsequent growth that the anterior parts become so strangely distorted. Both pairs of spiracles are accompanied by parastigmatic glands. Antenna with one long and several smaller curved bristles. Divisions of abdomen very indistinct. There appear to be four free segments above the pygidium. Pygidium in early examples (*fig.* 11) long and narrow, the sides slighty incurved, extremity roundly truncate. Lobes distinct and moderately prominent ; a broadly conical median pair,

followed closely by three duplex lateral lobes on each side, their free edges minutely serrate. No marginal spines or squames. During subsequent growth the base of the pygidium becomes considerably widened, and the lobes are entirely obliterated by the excessive deposition of chitinous matter (*fig.* 7), the outer lobes disappearing first (*fig.* 6). There are no circumgenital glands, the insect is therefore presumably ovoviviparous. Both surfaces of the pygidium bear small translucent spots, each with a minute central spine. Anal and genital apertures close to base of pygidium. Length, allowing for curve, about 1·75 mm.

Adult male unknown.

The female of second stage also lies in a curved position, but is not so strongly distorted as during the later stage. Colour bright pale yellow. The pygidium (*fig.* 13) terminates in two large and prominent pointed conical lobes, and on each side two smaller lateral lobes, duplex, each lobule sharply pointed.

At the time of the second moult the insect at first shrinks away from the pellicle and becomes much smaller than in the previous stage (*fig.* 12). If examined at this period only, it might be considered a *Fiorinia*, but it afterwards greatly increases in size, and ruptures the delicate pellicle which at first completely enclosed it.

Young larva not observed, but, judging from the character of the first pellicle (*fig.* 9), it must be of normal form.

Habitat, embedded in the substances of the bark and leaves of *Loranthus;* Pundaluoya. Examples from the leaves were collected at a different time and place from those on the stem, and it is remarkable that in the former case no specimens could be found on the stems of the plant, and in the latter none on the leaves. *Figs.* 1 to 7 are from examples obtained in the stems, the remainder from specimens imbedded in the leaves of the plant.

A very abnormal species, and only provisionally placed in the genus *Chionaspis*, with which it seems to have more affinity than with other *Diaspidinæ.* I purposely avoid founding a new genus upon the characters of a single species, as it is impossible to foretell which of such characters will prove common to the genus, and which peculiar to the species.

After examination of the adult insect only, Mr. Maskell was of opinion that it should be placed in his Idiococcid genus *Frenchia;* but the earlier stages clearly prove its proper position to be amongst the *Diaspidinæ.*

EXPLANATION OF PLATE LV.

CHIONASPIS FODIENS.

(*All figures, except Nos.* 1 *and* 8, *more or less enlarged.*)

Fig. 1. Stem of *Loranthus*, showing insects *in situ*, and tubercular swellings on the bark, nat. size.
2. Section of stem, showing the imbedded insects.
3, 4, 5. Adult female, different positions.
6. Pygidium of immature female.
7. " of adult female.
8. *Loranthus* leaf, with galls, nat. size.
9. Portion of leaf, with single gall, enlarged.
10. Male puparium.
11. Early adult female, ventral view.
12. Female, at time of second moult.
13. Pygidium of female, second stage, dorsal view.
14. Extremity of pygidium of early adult female.
15. Vertical section of leaf, showing adult female *in situ*.

CHIONASPIS GALLIFORMENS, *sp. nov.*

(PLATE LVI.)

Female puparium consisting of a thin film of secretionary matter lining the cavity of the gall-like swelling within which the insect is concealed. The pellicles usually wedged in the orifice of the gall, but sometimes absent. The development of the gall may be understood from an examination of the early stages. The larva, after having fixed itself upon the stem or leaf, gradually becomes enclosed by a thickening of the surrounding tissues (*fig.* 2). At the same time a hollow cell is formed below, increasing in size with the growth of the insect (*fig.* 3). There is always a central orifice corresponding with the original position of the larva. The outer walls of the cell are thickened and appear as nodular swellings on the young stems and petioles of the plant (*fig.* 1).

Male puparium (*fig.* 4) white; pellicle yellow. A very indistinct median ridge; no lateral carinæ.

Adult female (*fig.* 5) bright yellow; pygidium reddish brown. Eyes minute, blackish. Mouth-parts rather large and conspicuous. Both pairs of spiracles with parastigmatic glands. Abdomen with four free abdominal segments above the pygidium: a few small spiniform squames on lateral margins of second, third, and fourth segments. Pygidium (*fig.* 6) with four prominent pointed conical processes taking the place of the usual lobes; lateral margin with deep indentations and serrations. Only four lateral spaces, the normal base of the pygidium being separated off as the fourth free abdominal segment. Squames minute, spiniform, one on each of first and fourth spaces. A few conspicuous oval pores on both dorsal and ventral surfaces of pygidium. Circumgenital glands in five groups, with numerous orifices: median, 18 to 22; upper laterals, 24 to 32; lower laterals, 20 to 30. Anal anterior to genital aperture. Length about 1 mm. Breadth 0·62 mm.

Eggs numerous; bright orange yellow; deposited in the cavity of the gall.

Habitat concealed within gall-like protuberances on the young stems, petioles, and midrib of leaves of *Hedyotis lasertiana;* Kalutara (February, March). The position of the insect within the cavity varies; sometimes the anterior, sometimes the posterior extremity is found directed towards the orifice of the gall. The former position is probably assumed after impregnation. The male scales are clustered in the axils of the leaves and beneath the interpetiolar stipules.

The statement that this insect is without lobes on the pygidium appears at first sight to be contradicted by the figures. But I believe I am right in considering the conical processes to be thickened marginal prominences of a different nature to the lobes usually occurring on other species. It will be noticed that they are unaccompanied by any inward extension of the body wall.

EXPLANATION OF PLATE LVI.

CHIONASPIS GALLIFORMENS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Branch of *Hedyotis*, showing swellings formed by the female insects ; nat. size.

2. Young larva, on leaf.
3. Section of stem, showing adult female in its cell.
4. Male puparium.
5. Adult female, ventral view.
6. „ „ pygidium.

CHIONASPIS SIMPLEX, *sp. nov.*

(Plate LVII.)

Female puparium (*fig.* 2) snowy white, opaque, elongate, narrow, moderately convex above, often curved or much distorted. Pellicles yellow, transparent; the second pellicle usually partly obscured by an opaque covering of white secretion, the exposed parts appearing bright orange from the colour of the insect below. When freed from the scale by maceration, the margin of the second pellicle is found to be deeply incised and irregularly frayed (*fig.* 7); its extremity without lobes, and without any trace of the rostral apparatus and limbs. The first pellicle seems to be very easily detached. It is absent in the greater number of examples examined. The ventral scale is as well developed and as compact as the dorsal, completely enclosing the insect (*fig.* 3). The secretionary area resists, to a great extent, the action of boiling liquor potassæ. Length 2 to 2·50 mm. Breadth 0·50 to 1 mm.

Male puparium not known.

Adult female (*fig.* 4) bright orange: no eye-spots. Oblong oval, narrowly rounded in front, bluntly pointed behind. Four free abdominal segments above the pygidium. Margin of thoracic and abdominal segments with numerous pores communicating with small spinneret ducts. Parastigmatic glands represented by one to three pores at each spiracle. Pygidium (*figs.* 5, 6) without any lobes or squames. Margin with three main indentations indicating the boundaries of the first, second, and third spaces. The mesal incision is in the form of a minute pit. Four small hair-like spines on each side. Circumgenital glands in seven groups, encircling the genital aperture. The supplementary groups are situated on the first lateral space *posterior* to the normal lower laterals. Median group, 19 to 22; upper laterals, 30 to 35; lower laterals, 50 to 55; posterior groups, 15 to 25. Anal considerably anterior to genital aperture, close to base of pygidium. Both surfaces of pygidium minutely but strongly ribbed. On the ventral surface are numerous small circular pores, with thickened rims, scattered irregularly over the marginal area (*fig.* 5). On the dorsal surface the usual series of large oval pores are much broken up and displaced (*fig.* 6). Length 1·25 to 1·50 mm. Parasitised examples become abnormally distended and reach a length of 1·75 mm. Breadth, 0·60 to 0·75 mm.

Adult male unknown.

Eggs very numerous; bright orange yellow.

Young larva orange yellow; elongate; caudal setæ three-quarters length of body.

Habitat beneath leaf sheaths of the smaller twigs of the common yellow-stemmed bamboo. Pundaluoya. The scales are crowded together beneath the shelter of the imbricating sheaths. Though concealed from view, they are very extensively parasitised by minute hymenoptera.

This insect is doubtfully placed in the genus *Chionaspis*. I await the discovery of the male scale before finally settling its position. I have avoided founding the specific name upon the seven-grouped circumgenital glands, as this character may eventually prove of generic value. The name *simplex* is in reference to the margin of the pygidium, which is devoid of the usual fringe of lobes and squames.

(Since writing the above I have received from Mauritius (from M. d'Emmerez de Charmoy) examples of an insect that can only be separated from *Ch. simplex* by the absence of the supplementary circumgenital glands. In every other particular—including the habitat—the two forms are identical, and are clearly very closely allied. A new genus, therefore, can scarcely be founded upon the character of the gland groups in *Ch. simplex*.)

In some particulars this aberrant form approaches *Aspidiotus* (*Comstockiella*) *sabalis*. It also possesses characters that may associate it with *Odonaspis* (a sub-genus of *Aspidiotus*).

It is remarkable that so many *Coccidæ* from this same habitat (beneath the leaf sheaths of bamboo) should show abnormal characters; *e.g.*, *Aspidiotus secretus*, *A inusitatus*, and the present *Chionaspis simplex* amongst the *Diaspidinæ*. Other peculiar forms will be noticed amongst the *Lecaniinæ* and *Dactylopiinæ*.

EXPLANATION OF PLATE LVII.

CHIONASPIS SIMPLEX.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Twig of bamboo, with insects *in situ*, nat. size.
2. Female puparium, dorsal view.
3. „ „ ventral view.
4. Adult female, ventral view.
5. „ „ pygidium, ventral view.
6. „ „ „ dorsal view.
7. Second pellicle of female scale.

PARLATORIA, *Targ.*

In this genus the puparium of the female may be either sub-circular, ovoid, or elongate. The pellicles are partially overlapping and placed within the margin, at or towards the anterior extremity. In some few species the puparium consists principally of the large second pellicle, with only a very small secretionary supplement (*aonidiformis*, and the European species *zizyphi*). In others there is a large secretionary area supplementing the pellicles.

The male puparium is oblong and rather narrow; sides sub-parallel, with a median depression on the posterior half. The single pellicle placed at the anterior extremity. Secretionary area usually of somewhat the same colour and character as that of the female scale, but intermediate in this respect between the two groups of which *Aspidiotus* and *Diaspis* may be taken as typical genera.

In the adult female the most prominent characters are a fringe of fimbriate processes upon the margin of the pygidium and abdominal segments, and a marginal series of conspicuous semi-lunar pores, with thickened rims, communicating with stout cylindrical ducts. The abdominal segments merge gradually into the pygidium, and it is rather difficult to define the actual boundaries of this compound terminal segment, though the usual main divisions can be distinguished. For descriptive purposes it will be convenient to consider the fourth abdominal segment as representing the base of the pygidium. The median parts of the pygidium are usually more strongly chitinous than the marginal area, and appear of a darker colour in mounted preparations. Circumgenital glands usually in four groups; the missing median group rarely represented by a few isolated pores. The fimbriate processes are of the nature of squames, being connected with very delicate filiform spinneret ducts. There are normally six prominent single lobes at the extremity of the pygidium; and Professor Comstock has drawn attention to two smaller processes at intervals on the sides, which he considered to be rudimentary lobes. That such is the case is corroborated by the fact that in one of our Ceylon species (*P. aonidiformis*) one or more of these processes is not infrequently developed into a normal lobe. It is to the position of these rudimentary lobes that we must look for a clue to the boundaries of the suppressed segments. The dorsal pores, being more uniformly distributed, do not help us very much to a clear comprehension of the natural divisions. The large marginal semi-lunar pores appear to be intersegmental. I am inclined to take the boundary of each space at a point dividing the semi-lunar pores, and separating the two fimbriate squames that arise from them. Thus the mesal space will taper to a point meeting the margin between the median squames. Starting from the middle, the marginal dorsal characters of the first lateral space will be a dorsal squame, a lobe, a small spine, and a lateral squame. The second lateral space will bear, in order,

a mesal squame, a lobe, a spine, and two lateral squames. The third space has similar characters to the second, with the addition of a supplementary semi-lunar pore between the two lateral squames. The fourth space bears a mesal squame, a rudimentary lobe, a spine, and usually three lateral squames, with two supplementary pores. The basal space differs from the fourth only in the greater number (three or four) of lateral squames. (These divisions are indicated by dotted lines on *fig.* 7, plate lviii.) The dorsal pores have conspicuously thickened rims, and communicate with short stout cylindrical ducts. The anal aperture, in all known species, is considerably below the level of the genital orifice.

The adult male, in such species as have been examined, is very similar to that of *Aspidiotus*, being rather broad and dorso-ventrally depressed. The terminal joint of the antenna bears one or more knobbed hairs.

The three species described below have been discovered since the completion of Part I. of this work. According to the synopsis of genera, on p. 37, this genus should have followed *Aonidia.*

Our few Ceylon species are of no economic importance.

Synopsis of Species.

I. Scale with large secretionary area.
  A. Scale oblong. Pygidial lobes bicuspid......... 1. *mytilaspiformis.*
  B. Scale sub-circular. Pygidial lobes squarely truncate .... 2. *cingala.*

II. Scale consisting principally of the large second pellicle, with a very narrow secretionary border 3. *aonidiformis.*

PARLATORIA MYTILASPIFORMIS, *sp. nov.*

(PLATE LVIII.)

Female puparium (*fig.* 2) brownish fulvous, semi-transparent, paler at margin ; often irregularly veined. Pellicles clear yellow ; anterior margins thickened ; situate at anterior extremity. In fully developed examples the two pellicles together occupy less than half the total length of the scale. Form elongate, somewhat resembling that of *Mytilaspis* or *Chionaspis*, occasionally ovoid. Ventral scale attached a little within the margin of the dorsal scale, and appearing as a ragged whitish sub-marginal zone on the upturned puparium (*fig.* 3). Length 1·50 to 2 mm. Breadth 0·50 to 1 mm.

Male puparium (*fig.* 4) of normal form, elongate, median area depressed. Colour pale fulvous to whitish. Pellicle yellow, with greenish centre. Length 1 mm.

Adult female (*fig.* 5) narrowed in front, broadest across abdominal segments. Median area tumescent, purplish ; margin whitish. Cephalic extremity depressed above, the margin standing up as a thickened border. Pygidium very pale ochreous, tinged with reddish on the thickened median area. Spiracles without parastigmatic glands ; the anterior pair situate very high up, one on each side of rostrum. Lateral margins of abdominal segments with irregularly fimbriate processes. Pygidium (*fig.* 6) with typical marginal fringe. Lobes elongate and prominent, obscurely trifoliate, projecting beyond the squames. Squames elongate, narrow, fimbriate at extremity ; those between lobes narrow, the others much broader. The two small pointed marginal processes—the rudimentary fourth and fifth lateral lobes—are usually present, but their position is slightly variable ; one or both are sometimes obsolete. The usual semi-lunar marginal pores are large and conspicuous, especially those towards the extremity of the pygidium. Dorsal surface with numerous small oval pores. Circumgenital glands in four groups : number of orifices unusually constant, there being—in every example examined—6 in the upper laterals, and 5 in the lower lateral groups. Anal considerably below genital aperture. Length 0·75 to 1 mm. Breadth about 0·50 mm.

Adult male not known. Male pupa purplish.

Eggs pale purple, numerous, arranged in two rows beneath the scale (*fig.* 3).

Habitat on leaves of *Psychotria Thwaitesii ;* Pundaluoya. The female scales are situate on the upper, the males on the lower surface of the leaves. (Since found on tea plants, in the Udagama district.)

This species approaches very closely to *Parlatoria proteus*, Curtis. It may be distinguished by the elongate form of the female puparium, and by the more prominent and elongate lobes of the pygidium. In *proteus* the pellicle of the male puparium is said to be black.

EXPLANATION OF PLATE LVIII.

Parlatoria mytilaspiformis.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Psychotria*, with insects, nat. size.
2. Female puparium, from above.
3. " " from below.
4. Male puparium.
5. Adult female, dorsal view.
6. " " pygidium, dorsal view.
7. " " " ventral view of margin.

PARLATORIA CINGALA, *sp. nov.*

(PLATE LIX.)

Female puparium circular, flattish ; pale yellow (*fig.* 2) or brownish ochreous (*fig.* 7), according to the position of the scale on the under or upper surface of the leaf respectively ; margin colourless, thin, and semi-transparent. Pellicles overlapping ; pale yellow ; sub-marginal. Diameter 1·50 to 1·75 mm.

Male puparium (*fig.* 3) white or faintly tinged with yellow ; oblong, posterior half depressed, with indistinct sub-lateral ridges ; semi-transparent, the colour of the pupa (brownish purple) showing indistinctly through the scale. Pellicle at anterior extremity; yellow. Length 1 mm.

Adult female (*fig.* 4) broadly rounded in front, pointed behind; breadth almost equal to length; broadest across metathorax; median area tumescent, marginal area flattened; abdominal segments moderately distinct. Colour pale yellow, pygidium and rostral parts tinged with reddish brown. Position of circumgenital glands marked in the living insect by patches of white waxy matter. Spiracles small and inconspicuous, the anterior pair placed far forward on a level with the anterior parts of the rostrum. Parastigmatic glands consisting of two pores only at each of the anterior spiracles. Margin of abdominal segments with a fringe of prominent tubular processes like truncate spines. These processes are unconnected with any spinneret ducts, but appear to be perforate at extremity. Pygidium (*fig.* 5) with six prominent lobes at extremity, all of about the same size, narrowed at base, free edge sharply and straightly cut, inner edge longest. The usual rudimentary lobe on the fourth space is here replaced by a very broad rounded lobe projecting only slightly beyond the margin, its free edge forming an even curve. This is followed by a small spine-like process and two conical marginal prominences in place of the usual fimbriate squames. The base bears two conical points and three or four longish tubular processes similar to those on the abdominal segments. Semi-lunar pores between the lobes of normal form, but those on third and fourth spaces are more of the oval type found in *Chionaspis*. Dorsal pores rather numerous, situate between the thickened median area and the margin. A few small circular pores on ventral surface. Circumgenital glands in four groups; upper laterals, 10 to 14; lower laterals, 9 to 14. Anal at some distance below genital aperture. Length about 0·75 mm. Breadth about 0·50 mm.

Adult male not known.

Eggs and young larvæ pale yellow.

Habitat on leaves of *Flacourtia* and *Scolopia*; Pundaluoya ; Nuwara Eliya. The scales occur on both surfaces of the leaves. Those on the upper surface are brownish (*fig.* 7), while those on the under surface are distinctly yellow (*fig.* 2).

Easily distinguishable from any other described species by the form of the lobes and the tubular marginal processes on the lateral margin.

EXPLANATION OF PLATE LIX.

PARLATORIA CINGALA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaves of *Flacourtia*, with scales, nat. size.
2. Female puparium, from under surface of leaf
3. Male puparium.
4. Adult female, ventral view.
5. ,, ,, pygidium, dorsal view.
6. Margin of pygidium.
7. Female puparium, from upper surface of leaf.

PARLATORIA AONIDIFORMIS, *sp. nov.*

PLATE LX.

Female puparium (*fig.* 3) very small; covered almost completely by the second pellicle; a very narrow secretionary border. Pellicles fulvous; the second tinged with red, especially at posterior extremity. The second pellicle has a prominent median ridge, bifurcating in front to give space to the first pellicle. Under surface (*fig.* 4) completely closed in by the ventral parts of the second pellicle, within which the adult female and eggs remain concealed, as in the genus *Aonidia.* Towards the posterior extremity of the ventral surface, but within the margin, is a well-defined depressed area resembling the pygidium of the insect, and itself bordered by a separate zone of secretionary matter. On breaking away the ventral scale, the adult female, which is much smaller than in the previous stage, can be seen in the anterior part of the cavity (*fig.* 5), the hinder part being occupied by the comparatively large purplish eggs, which are deposited in two rows. Total length of puparium rather less than 1 mm. Breadth almost equal to length. Second pellicle measuring 0·75 by 0·50 mm.

Male puparium (*fig.* 2) of normal form; oblong, slightly dilated behind; hinder part with median depression and faint trace of median ridge. Pellicle yellowish, with semi-transparent greenish median area. Secretionary area very pale fulvous or whitish. Length 1 mm.

Adult female (*fig.* 6) with flattened expanded margin and tumescent median area. Colour purplish, fading to creamy white at margin; pygidial extremity pale fulvous. No parastigmatic glands. Mouth-parts rather large. Abdominal segments almost destitute of fringed processes. Pygidium (*fig.* 7) with six prominent chitinous lobes, decreasing in size from the centre outwards. The rudimentary lobe on fourth space occasionally fully developed on one or both sides. Each lobe constricted at base, with sharply pointed extremity; a single notch on the inner and two notches on the outer edge. The fimbriate squames unusually long and narrow, fringed at extremity only. Semi-lunar pores small and inconspicuous, in connexion with narrow cylindrical ducts. Marginal spines situate upon prominent tubercles in the intervals between the squames, except in such intervals as are occupied by the semi-lunar pores. Basal space laterally produced, with deep and irregular incisions between the squames. Dorsal pores few, minute and inconspicuous. Circumgenital glands in four groups; upper laterals, 4 to 5; lower laterals, 5 to 6. Anal slightly posterior to genital aperture. Length of extended example 0·50 mm.

Adult male not known.

Habitat on upper surface of leaves of *Nothopegia colebrookiana;* Pundaluoya.

A minute and inconspicuous insect, somewhat abnormal in form. But a careful examination shows that in every important structural character it conforms with the genus *Parlatoria.* The male puparium is quite typical.

EXPLANATION OF PLATE LX.

Parlatoria aonidiformis.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Nothopegia*, with insects *in situ*, nat. size.
2. Male puparium.
3. Female puparium, from above.
4. „ „ from below.
5. „ „ with ventral scale removed.
6. Adult female, ventral view.
7. „ „ pygidium.

Fig. 1.

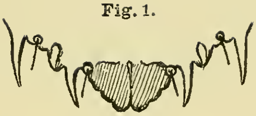


Fig. 2.

Fig. 3.

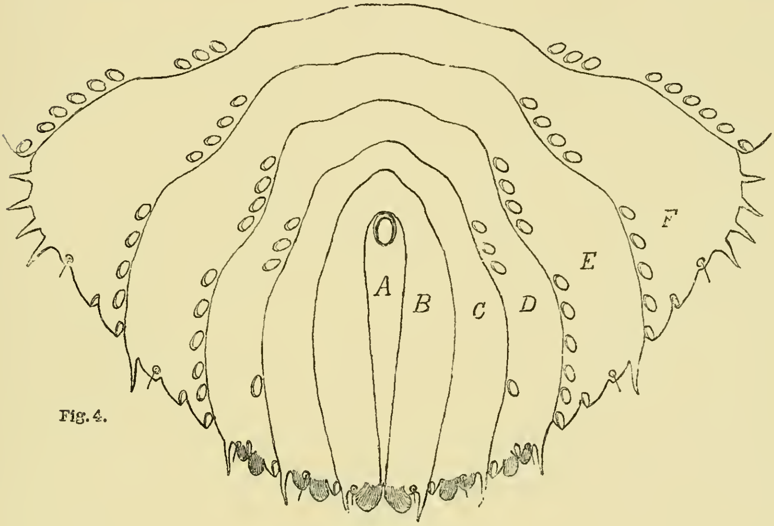


Fig. 4.

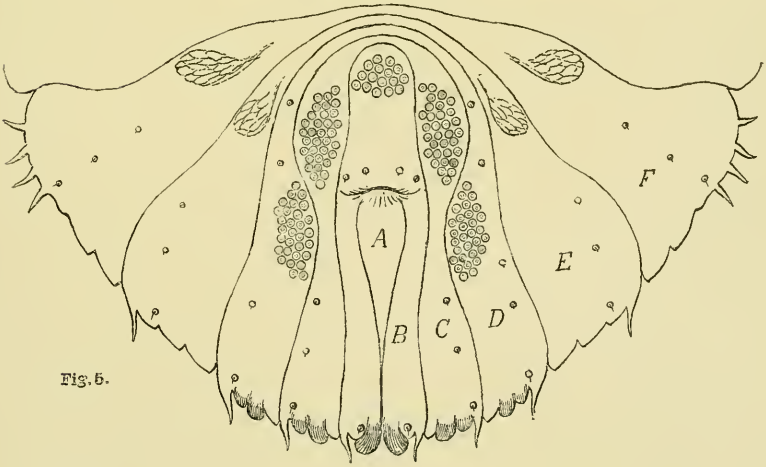


Fig. 5.

E. E. Green del.

STRUCTURAL CHARACTERS OF CHIONASPIS.

EXPLANATION OF PLATE XXXII.

CHIONASPIS ASPIDISTRÆ.

(*All figures, except No.* 10, *more or less enlarged.*)

Fig. 1. Adult male, dorsal view.
2. Male puparium, from above.
3. Foot of adult male.
4. Terminal joint of antenna of male.
5. Egg.
6. Young larva.
7. Adult female (from *Acacia*), ventral view.
8. Pygidium of female (from Fern).
9. Adult female (from Fern), dorsal view.
10. Piece of Fern (*Thamnopteris nidus*) with insects *in situ*, nat. size.
11. Female puparium, early adult (from Fern).
12. " " later stage " "
13. " " (from *Cyanotis*).
14. Antenna of female (from Fern).
15. " " (from *Acacia*).
16. Pygidium of female (from *Areca*).
17. Posterior extremity of second pellicle (from Fern).

Pl. XXXII.

E. E. Green ad nat del.

CHIONASPIS ASPIDISTRÆ.

EXPLANATION OF PLATE XXXIII.

CHIONASPIS THEÆ.

(*All figures, with exception of No.* 8, *more or less enlarged.*)

Figs. 1, 2, 3, 4, 15. Successive stages in growth of male puparium
Fig. 6. Male puparium, from below, showing pupa *in situ.*
7. ,, ,, side view.
8. Leaf of tea plant, with insects, nat. size.
9. Female puparium, from above.
10. Adult female, ventral view.
11. ,, ,, pygidium, dorsal view.
12. Adult male, dorsal view.
13. ,, ,, terminal joints of antenna.
14. ,, ,, foot.

Pl. XXXIII.

E.E. Green ad nat del P.W.M.T. impr. A.J.J.W. lith

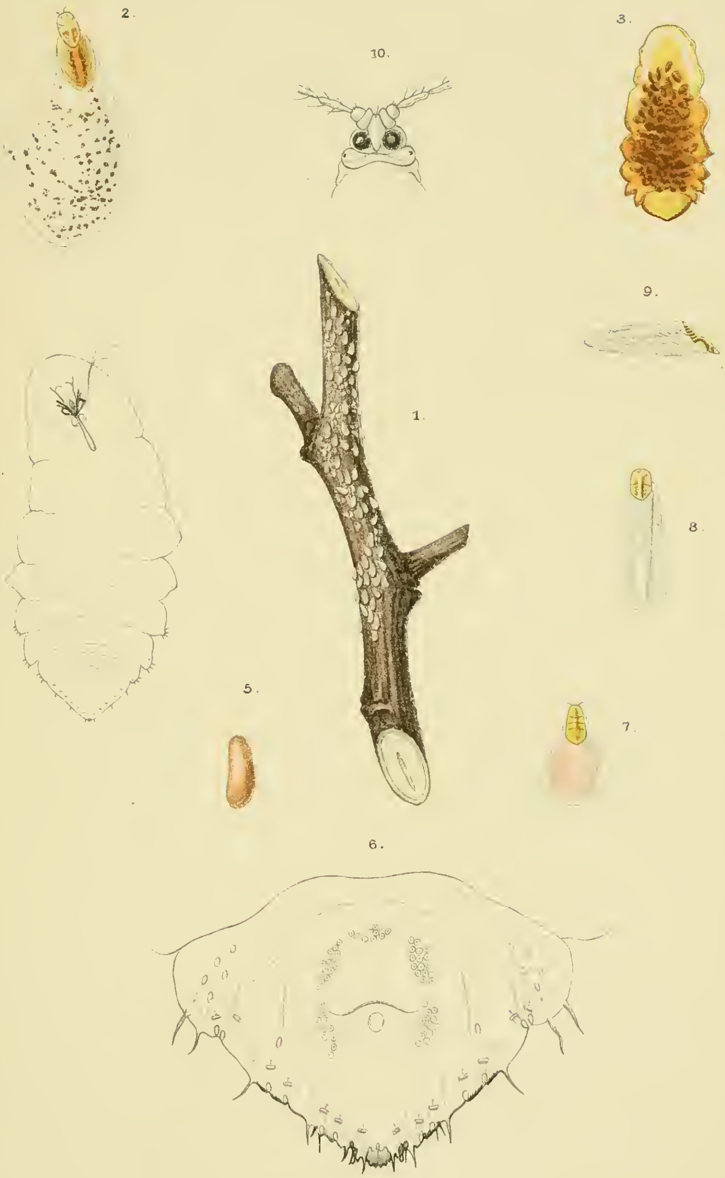
CHIONASPIS THEÆ.

EXPLANATION OF PLATE XXXIV.

Chionaspis albizziæ.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of *Albizzia* stem, with male and female scales, nat. size.
2. Female puparium, from above.
3. Adult female, dorsal view.
4. ,, ,, more enlarged, after maceration.
5. Egg.
6. Pygidium of adult female, ventral view.
7. Female scale, second stage.
8. Male puparium, from above.
9. ,, ,, side view.
10. Head of adult male, dorsal view.



E E Green ad nat. del   P.W.M.T. impr   A J. J. W. lith

CHIONASPIS ALBIZZIÆ.

EXPLANATION OF PLATE XXXV.

CHIONASPIS MUSSÆNDÆ.

(*All figures, except No.* 6, *more or less enlarged.*)

Fig. 1. Adult male, dorsal view.
2. Male puparium, from above.
3. " " diagrammatic section.
4. Leg of adult male.
5. Terminal joint of male antenna.
6. Twig of *mussænda*, with insects *in situ*, nat. size.
7. Pygidium of adult female.
8. Female puparium, from older (smooth) bark.
9. " " from the young (hairy) bark.
10. Adult female, ventral view, before oviposition.
11. " " " " after "
12. " " dorsal view.
13. Posterior extremity of second pellicle.

Pl. XXXV.

ÉE.Green ad nat. del P.W.M.T impr. A.J.J.W. lith.

CHIONASPIS MUSSÆNDÆ.

EXPLANATION OF PLATE XXXVI.

CHIONASPIS RHODODENDRI.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Rhododendron leaf showing discoloured spots on upper surface which mark the position of the insects below.

2. Female puparium.
3. Male ,,
4. Adult female, ventral view.
5. Female pygidium, dorsal view.

Pl. XXXVI.

E.E.Green ad nat. del. P.W.M.T. impr. A.J.J.W. lith.

CHIONASPIS RHODODENDRI.

EXPLANATION OF PLATE XXXVII.

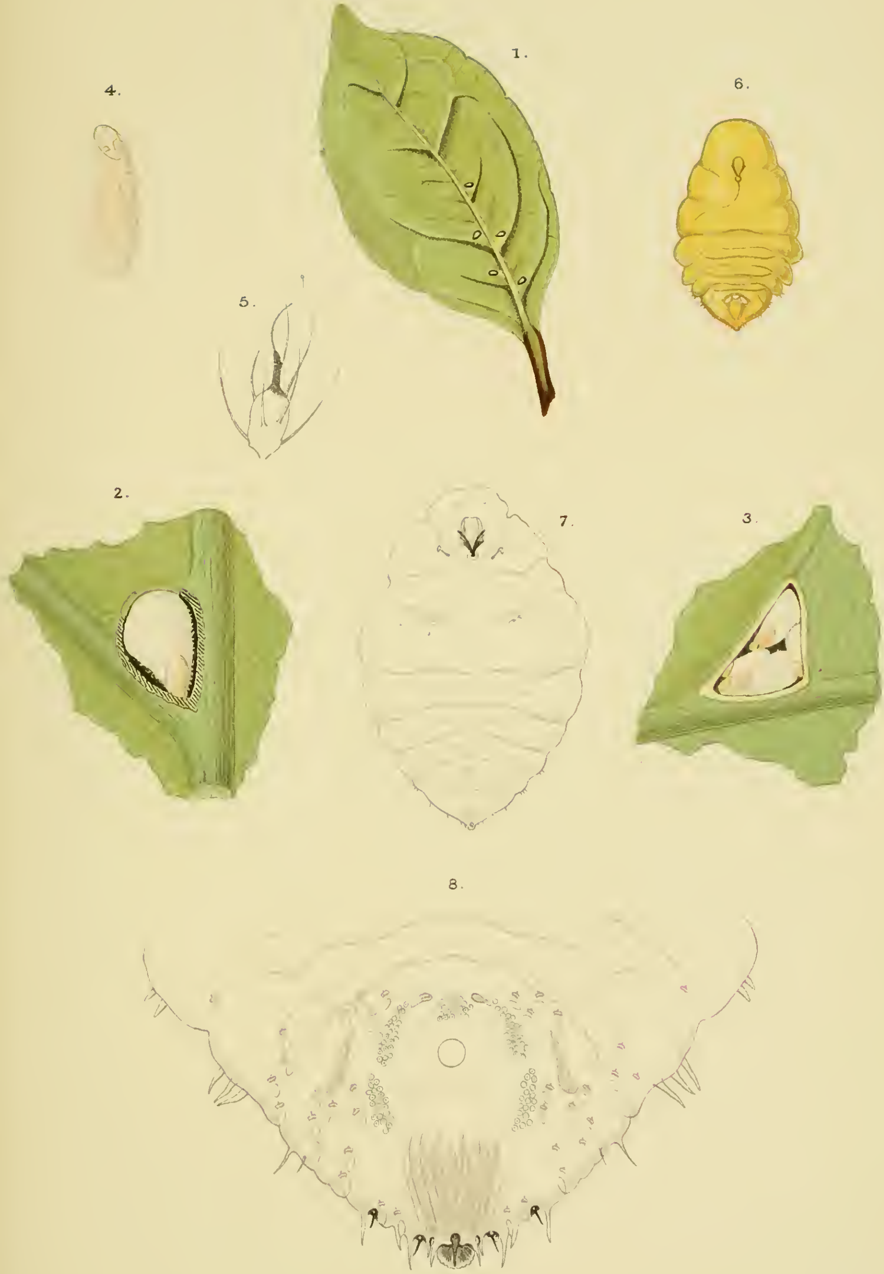
CHIONASPIS SCROBICULARUM.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Elæocarpus*, nat. size, showing glandular pits occupied by the insects.

2. A glandular pit opened, showing female puparium.
3. ,, ,, ,, showing group of male and female puparia.
4. Male puparium.
5. Terminal joint of male antenna.
6. Adult female, ventral view.
7. ,, ,, after maceration, showing position of the various organs.
8. Pygidium of female, dorsal view.

Pl. XXXVII.



E.E. Green ad nat del. P.W.M.T. impr A.J.J.W. lith.

CHIONASPIS SCROBICULARUM.

EXPLANATION OF PLATE XXXVIII.

CHIONASPIS GRAMINIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of ' Mana ' grass, with insects *in situ*, nat. size.
2. Female puparium, with reddish pellicle.
3. Adult female, dorsal view.
4. Male puparium, with brownish pellicle.
5. " " " powdery covering.
6. " " " pale pellicle.
7. Female puparium, from below, showing insect and ova.
8. Newly hatched larva.
9. Pygidium of female, var. *divergens.*
10. " " typical form.
11. Female puparium, of second stage.
12. " " from below, showing ventral scale intact.
13. " " from above, with pale pellicles.

Pl. XXXVIII.

E.E.Green ad nat del. P.W.M.T. impr. A.J.J. W. lith.

CHIONASPIS GRAMINIS.

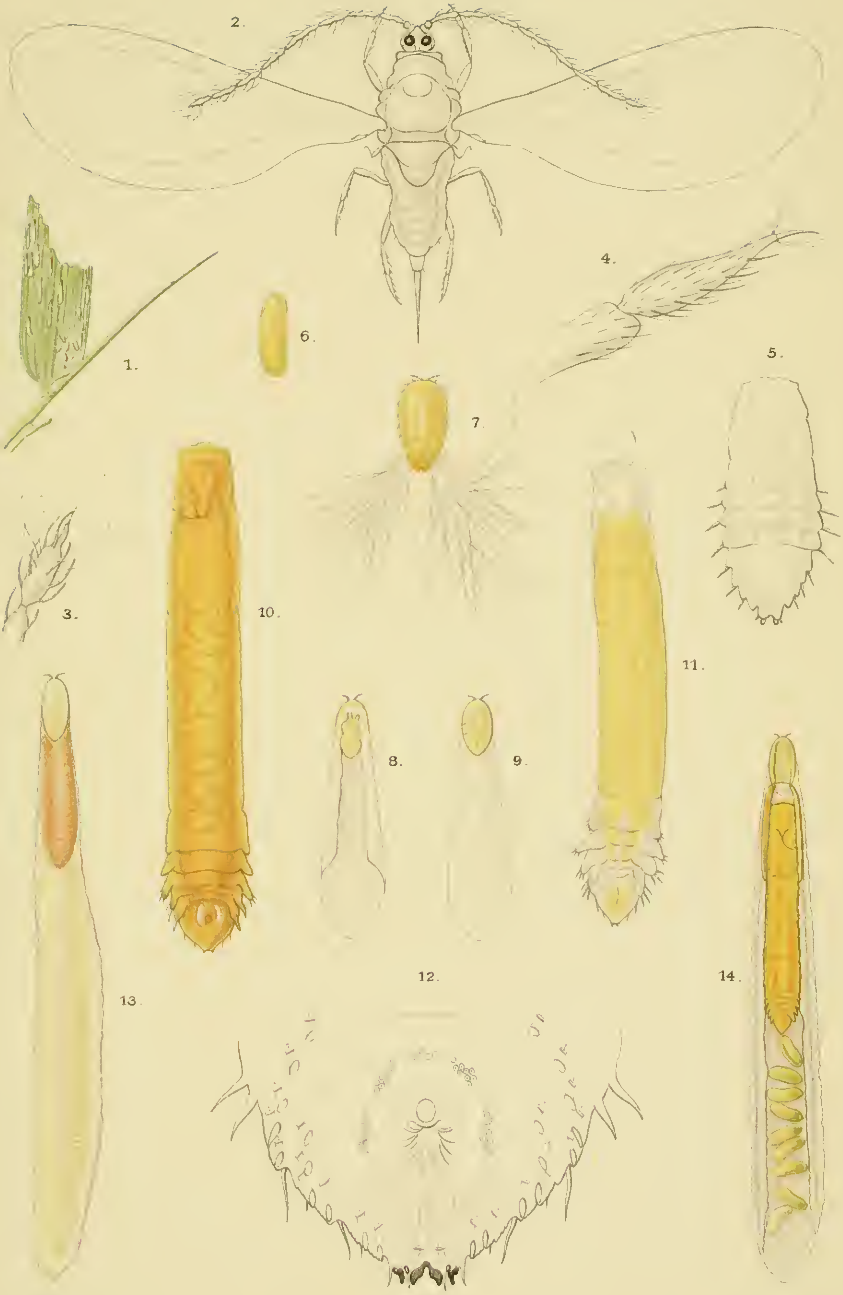
EXPLANATION OF PLATE XXXIX.

Chionaspis elongata.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of bamboo leaf, ♂ and ♀ insects *in situ*, nat. size.
2. Adult male, dorsal view.
3. „ „ terminal joint of antenna.
4. „ „ leg.
5. Female of second stage.
6. Egg.
7. Male larva, showing filamentary tufts.
8. Male puparium, from below.
9. „ „ „ above.
10. Adult female, ventral view.
11. „ „ dorsal view, before gestation.
12. „ „ pygidium.
13. Female puparium, from above.
14. „ „ „ below.

Pl. XXXIX.



E.E.Green ad nat. del

P.W.M.T. impr.

A.J.J.W. lith.

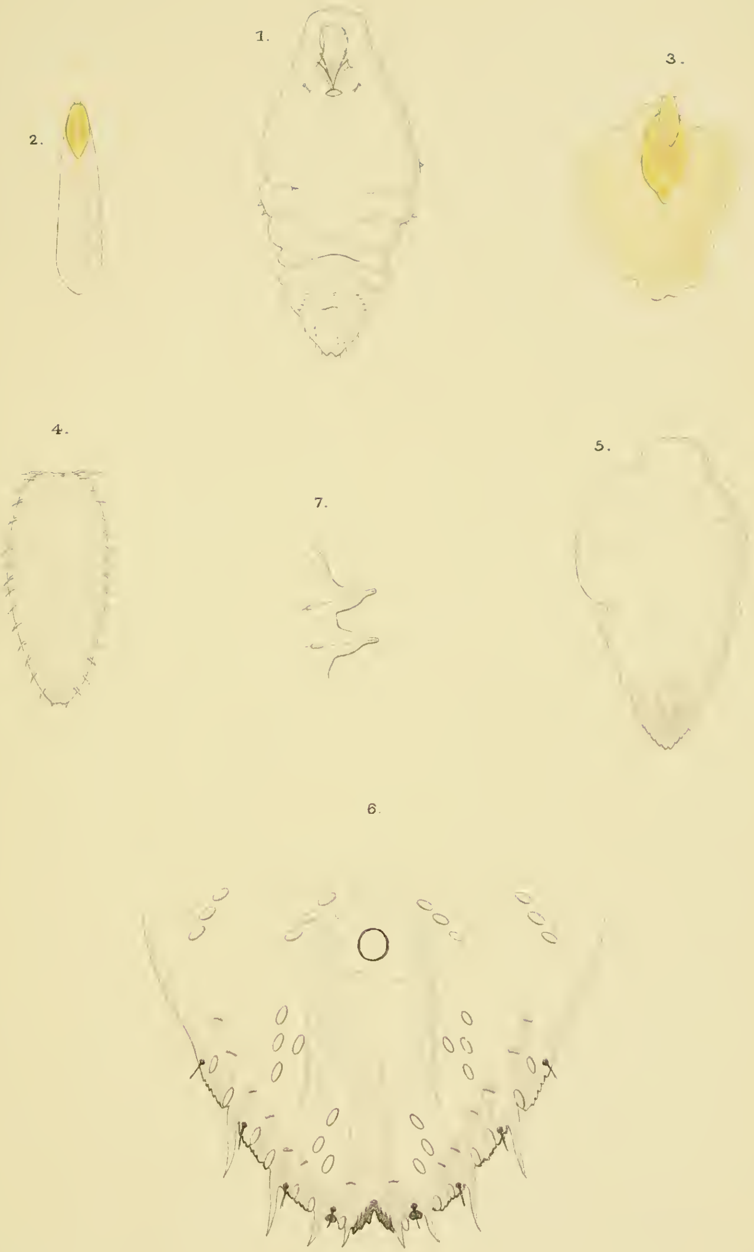
CHIONASPIS ELONGATA.

EXPLANATION OF PLATE XL.

Chionaspis arundinariæ.

Fig. 1. Adult female, ventral view.
2. Male puparium, from above.
3. Female puparium, from above.
4. „ „ first pellicle.
5. „ „ second pellicle.
6. Pygidium of adult female, dorsal view.
7. Margin of metathorax, with tubular processes.

Pl. XL.



E E Green ad nat. del. PWMT. impr. A.J.J W. lith

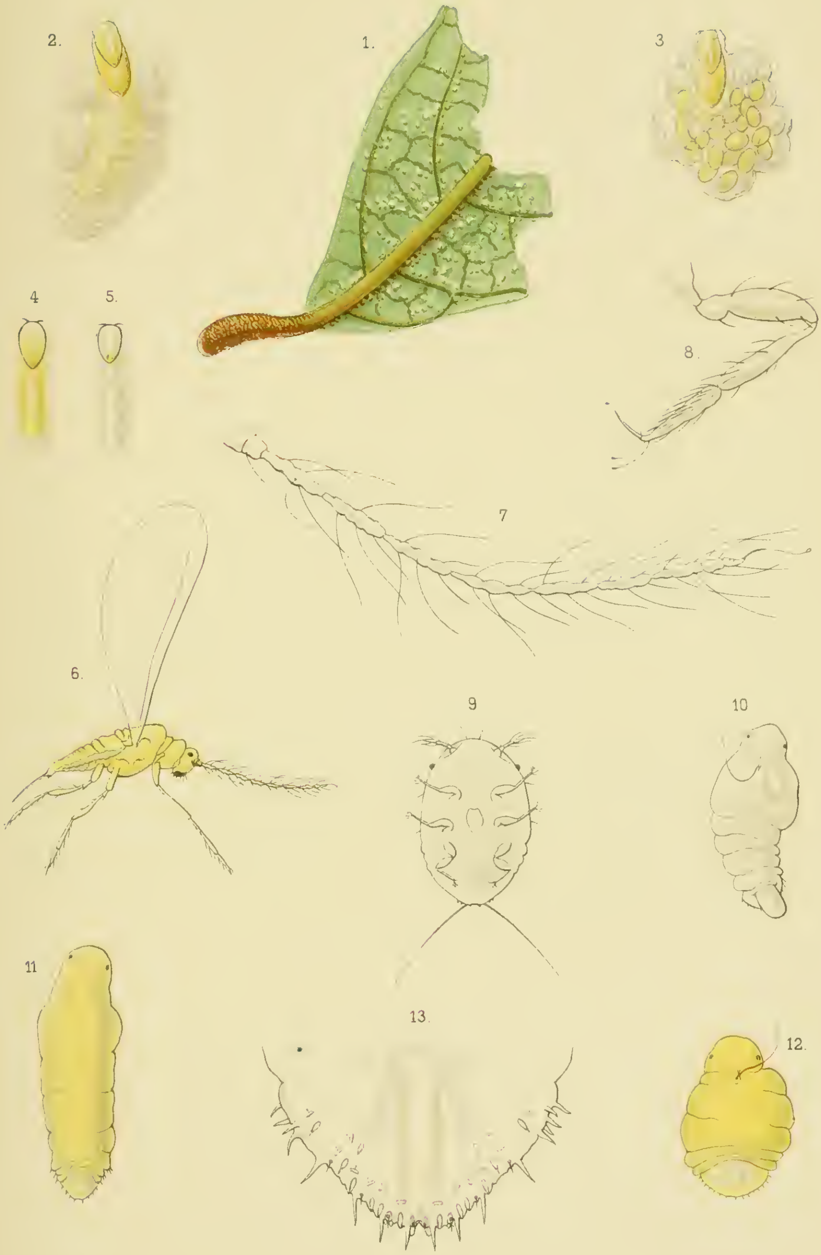
CHIONASPIS ARUNDINARIÆ.

EXPLANATION OF PLATE XLI.

CHIONASPIS MINUTA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of leaf, with insects *in situ*, nat. size.
2. Female puparium.
3. „ „ containing eggs.
4. Male puparium, containing pupa.
5. „ „ empty.
6. Adult male, lateral view.
7. „ „ antenna.
8. „ „ leg.
9. Young larva.
10. Adult female, during oviposition.
11. „ „ dorsal view.
12. „ „ ventral view, after oviposition.
13. „ „ pygidium, ventral view.



E.E. Green del.

P.W.M. Trap imp.

CHIONASPIS MINUTA

EXPLANATION OF PLATE XLII.

CHIONASPIS PERMUTANS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig 1. Leaf of *Antidesma*, with insects, nat. size.
2. Female puparium, from above.
3. Adult female, after gestation, ventral view.
4. Early adult female, dorsal view.
5. Puparium of early adult female.
6. Adult female, transition stage, ventral view.
7. Female puparium, from below, with insect *in situ.*
8. Adult female, transition stage, dorsal view.
9. Pygidium of adult female.
10. Adult male, dorsal view.
11. " " terminal joint of antenna.
12. Male puparium.

CHIONASPIS PERMUTANS.

EXPLANATION OF PLATE XLIII.

CHIONASPIS HERBÆ.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Grass stem (*Panicum* sp.) with insects *in situ.*
2. Female puparium, from *Ischæmum ciliare.*
3. „ „ from *Panicum* sp.
4. „ „ showing ventral scale.
5. Male puparium.
6. Adult female, dorsal view.
7. Margin of pygidium of living female, showing secretionary filaments.
8. Pygidium of female, dorsal view.
9. „ „ ventral view of extremity
10. Rudimentary eye of adult male.

CHIONASPIS HERBÆ.

EXPLANATION OF PLATE XLIV.

CHIONASPIS POLYGONI.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Insects *in situ*, nat. size, on stem of *Polygonum*.
2. Male puparium.
3. Female puparium.
4. " "
5. Adult female, dorsal view.
6. Pygidium of female, dorsal view.
7. " " " showing variation in lateral lobes.

E. E. Green ad nat del. P.W.M.T impr. A J J Wilth

CHIONASPIS POLYGONI.

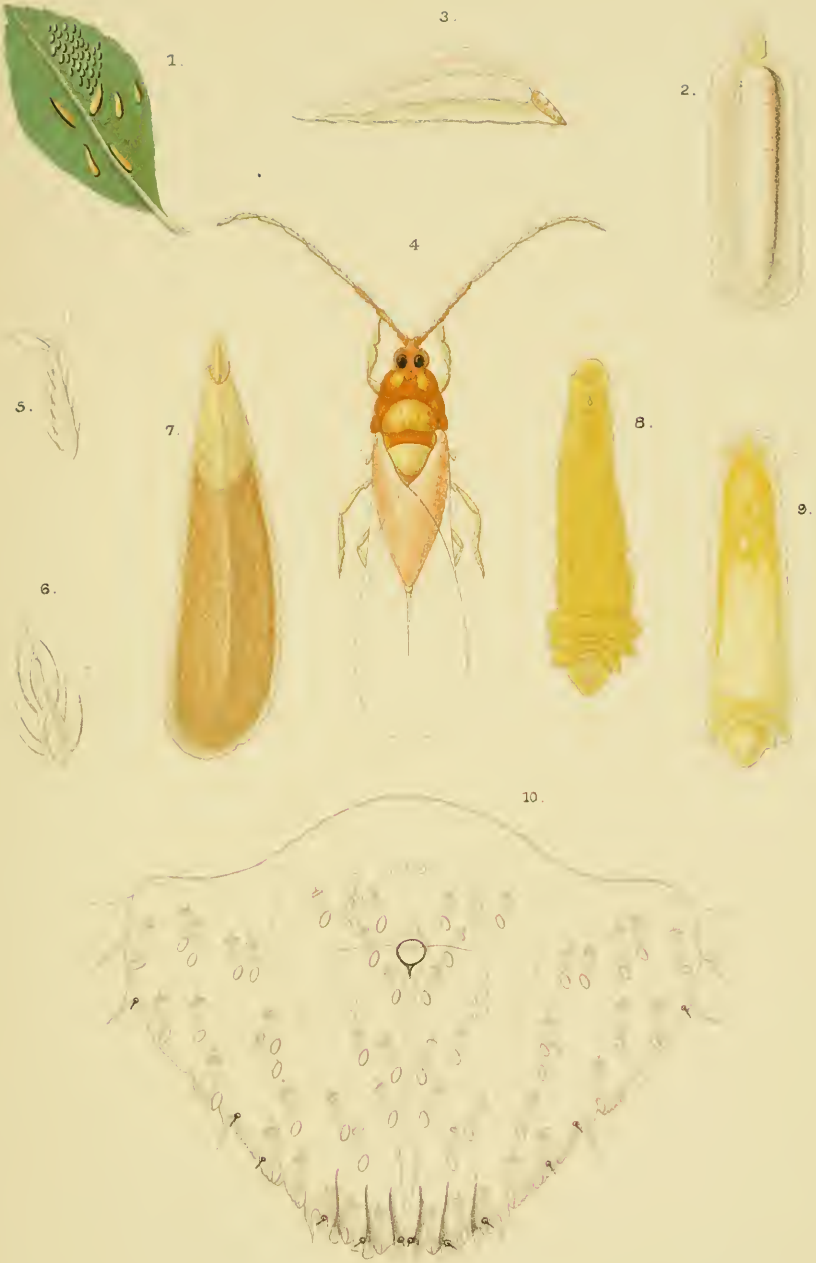
EXPLANATION OF PLATE XLV.

CHIONASPIS ACUMINATA.

(*All figures, except No.* 1, *more or less enlargea.*)

Fig. 1. Leaf with insects *in situ*, nat. size.
2. Male puparium, dorsal view.
3. „ „ side view.
4. Adult male.
5. „ „ foot.
6. „ „ terminal joint of antenna.
7. Female puparium, dorsal view.
8. Adult female, ventral view.
9. „ „ older example, dorsal view.
10. „ „ pygidium.

Pl. XLV.



E.E.Green ad nat. del. F.W.M.T. impr. A.J.J.W. lith.

CHIONASPIS ACUMINATA.

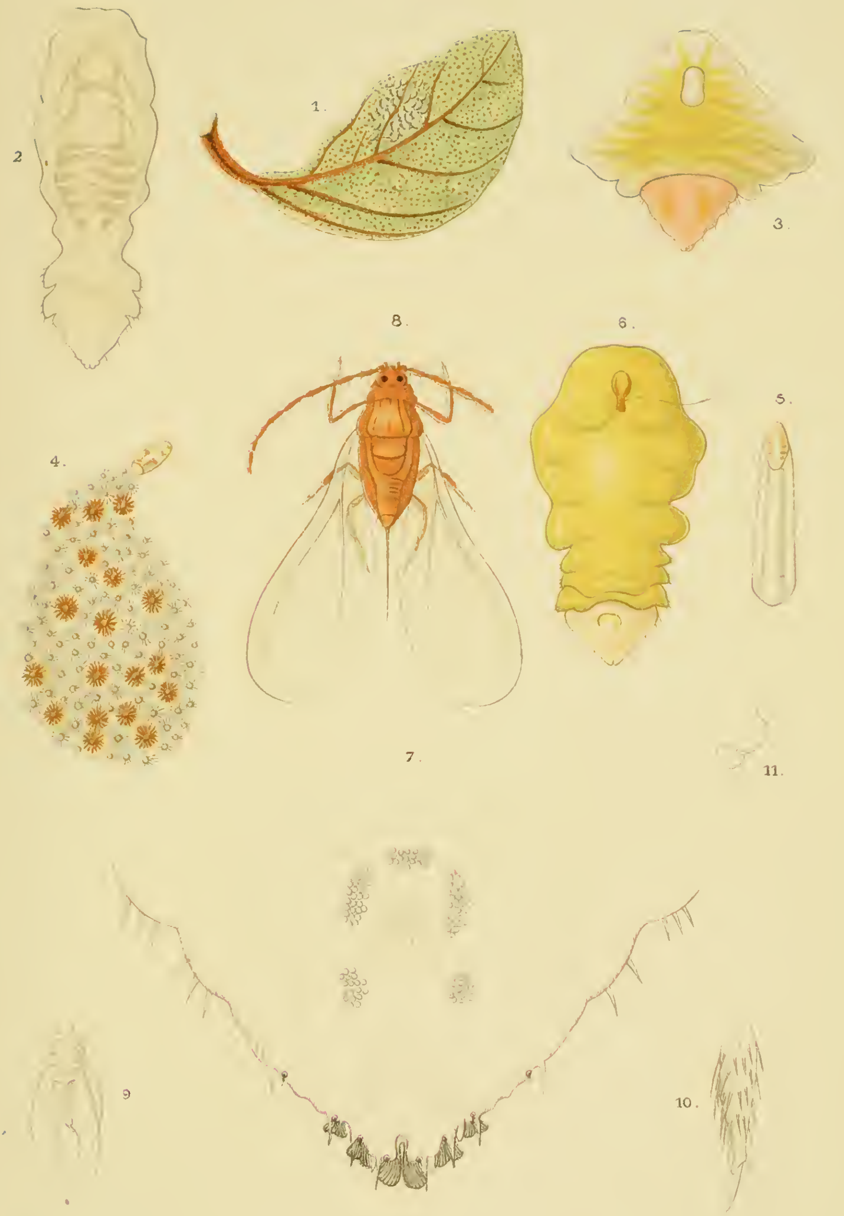
EXPLANATION OF PLATE XLVI.

CHIONASPIS ELÆAGNI.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Elæagnus*, with insects *in situ*, nat. size.
2. Adult female, containing pupa of parasite.
3. " " after oviposition, dorsal view.
4. Female puparium.
5. Male "
6. Adult female, before oviposition, ventral view.
7. " " pygidium.
8. Adult male, dorsal view.
9. " " terminal joint of antenna.
10. " " foot.
11. Rudimentary antenna of female.

Pl. XLVI.



PWM imp. A J W lith.

CHIONASPIS ELÆAGNI

EXPLANATION OF PLATE XLVII.

CHIONASPIS VITIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Vitis sp.*, with insects, nat. size.
2. Female puparium, occupied by insect and eggs.
3. „ „ empty.
4. Adult female, before gestation, ventral view.
5. „ „ containing ova, dorsal view.
6. „ „ pygidium.
7, 8, 9. Stages in growth of male puparium.
10. Adult male, dorsal view.
11. „ „ foot.
12. Young larva.
13. Terminal joint of antenna of male.

Pl. XLVII.

E.E. Green del. P.W.M. Trap imp. A.J.J.W lith.

CHIONASPIS VITIS.

EXPLANATION OF PLATE XLVIII.

Chionaspis hedyotidis.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of *Hedyotis auricularia*, with insects, nat. size.
2. Female puparium.
3. Male puparium.
4. Terminal joint of male antenna.
5. Adult female, dorsal view.
6. „ „ pygidium, dorsal view.

E.E Green del.

P.W.M. Trap imp.

CHIONASPIS HEDYOTIDIS,

EXPLANATION OF PLATE XLIX.

CHIONASPIS LITZEÆ.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Litzea zeylanica*, with insects, nat. size.
2. Female puparium.
3. Male puparium.
4. Adult female, before oviposition, dorsal view.
5. „ „ pygidium, dorsal view.
6. Terminal joint of antenna of adult male.
7. Foot of male.

E.E.Green del.

P.W.M.

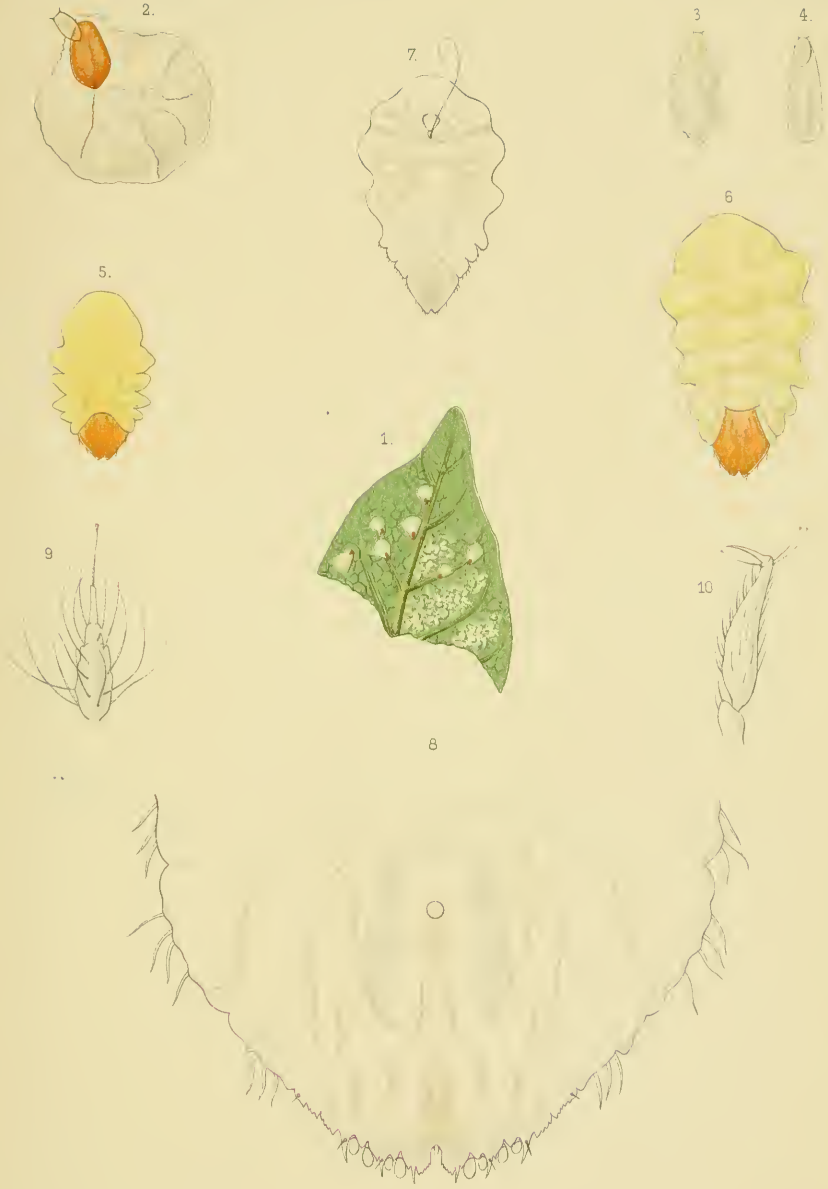
CHIONASPIS LITZEÆ

EXPLANATION OF PLATE L.

CHIONASPIS VARICOSA.

(*All figures, except No.* 1, *more or less enlarged.*

Fig. 1. Part of leaf of *Gelonium*, with insects, nat. size.
2. Female puparium.
3. Male ,,
4. ,, with fibrous covering removed.
5, 6. Adult female, dorsal view.
7. ,, ,, ventral view.
8. ,, ,, pygidium.
9. Terminal joint of antenna of male.
10. Foot of male.



E.E. Green del.

CHIONASPIS VARICOSA.

EXPLANATION OF PLATE LI.

CHIONASPIS DILATATA.

(*All figures except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of leaf of *Eurycles*, with insects, nat. size.
2. Female puparium.
3. Male puparium.
4. Adult female, ventral view.
5. „ „ pygidium, dorsal view.

1.

4

2

3.

5

CHIONASPIS DILATATA.

EXPLANATION OF PLATE LII.

CHIONASPIS MEGALOBA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf, with insects *in situ*, nat. size.
2. Male puparium.
3. Female puparium.
4. Adult female.
5. „ „ pygidium.

CHIONASPIS MEGALOBA.

EXPLANATION OF PLATE LIII.

CHIONASPIS FLAVA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Antidesma*, with insects *in situ*, nat. size.
2. Female puparium, old scale.
3. Male puparium.
4. Adult female, after gestation.
5. ,, ,, before gestation.
6. Female puparium, early adult scale.
7. ,, ,, from below.
8. Adult female, ventral view.
9. ,, ,, pygidium, dorsal view.
10. ,, ,, antenna.

E.E. Green ad nat. del. P.W.M.T. impr. A.J.J.W. lith.

CHIONASPIS FLAVA.

EXPLANATION OF PLATE LIV.

Chionaspis biclavis.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Piece of cinchona stem, with insects *in situ*, nat. size.
2. Piece of bark from tea stem, enlarged, showing two scales.
3. Female puparium, from above.
4. ,, ,, from below.
5. Early adult female, dorsal view.
6. Later stage ,, ,, ,,
7. Adult female, fully developed, dorsal view.
8. ,, ,, ,, ,, ventral ,,
9. ,, ,, pygidium, dorsal view.
10. ,, ,, antenna.
11. Abdominal extremity of young larva.

Pl. LIV.

E.E. Green del. P.W.M.T. impr. A.J.J.W. lith.

CHIONASPIS BICLAVIS.

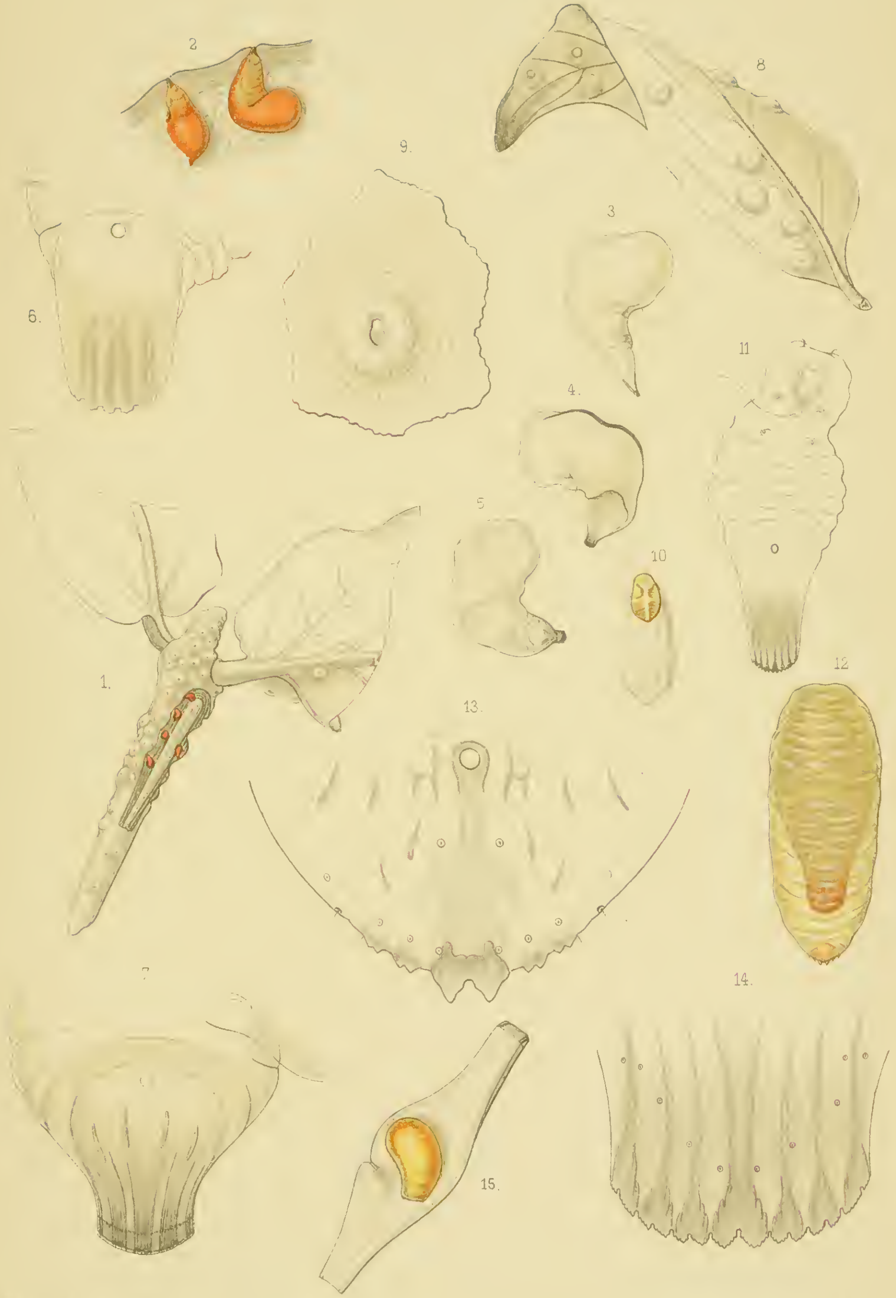
EXPLANATION OF PLATE LV.

Chionaspis fodiens.

(*All figures, except Nos.* 1 *and* 8, *more or less enlarged.*)

Fig. 1. Stem of *Loranthus*, showing insects *in situ*, and tubercular swellings on the bark, nat. size.

2. Section of stem, showing the imbedded insects.
3, 4, 5. Adult female, different positions.
6. Pygidium of immature female.
7. „ of adult female.
8. *Loranthus* leaf, with galls, nat. size.
9. Portion of leaf, with single gall, enlarged.
10. Male puparium.
11. Early adult female, ventral view.
12. Female, at time of second moult.
13. Pygidium of female, second stage, dorsal view.
14. Extremity of pygidium of early adult female.
15. Vertical section of leaf, showing adult female *in situ.*



P.W.M. Trap imp.

CHIONASPIS FODIENS

EXPLANATION OF PLATE LVI.

CHIONASPIS GALLIFORMENS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Branch of *Hedyotis*, showing swellings formed by the female insects ; nat. size.
2. Young larva, on leaf.
3. Section of stem, showing adult female in its cell.
4. Male puparium.
5. Adult female, ventral view.
6. „ „ pygidium.

CHIONASPIS GALLIFORMENS.

EXPLANATION OF PLATE LVII.

CHIONASPIS SIMPLEX.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Twig of bamboo, with insects *in situ*, nat. size.
2. Female puparium, dorsal view.
3. " " ventral view.
4. Adult female, ventral view.
5. " " pygidium, ventral view.
6. " " " dorsal view.
7. Second pellicle of female scale.

Pl LVII

CHIONASPIS SIMPLEX.

EXPLANATION OF PLATE LVIII.

PARLATORIA MYTILASPIFORMIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Psychotria*, with insects, nat. size.
2. Female puparium, from above.
3. ,, ,, from below.
4. Male puparium.
5. Adult female, dorsal view.
6. ,, ,, pygidium, dorsal view.
7. ,, ,, ,, ventral view of margin.

E. E. Green del. F. W. M. T. imp. A. J. J. W. lith.

PARLATORIA MYTILASPIFORMIS.

EXPLANATION OF PLATE LIX.

PARLATORIA CINGALA.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaves of *Flacourtia*, with scales, nat. size.
2. Female puparium, from under surface of leaf
3. Male puparium.
4. Adult female, ventral view.
5. ,, ,, pygidium, dorsal view.
6. Margin of pygidium.
7. Female puparium, from upper surface of leaf.

Pl. LIX.

PARLATORIA CINGALA.

Pl. LX.

E.E.Green del.

PARLATORIA AONIDIFORMIS.

EXPLANATION OF PLATE LX.

PARLATORIA AONIDIFORMIS.

(*All figures, except No.* 1, *more or less enlarged.*)

Fig. 1. Leaf of *Nothopegia,* with insects *in situ*, nat. size.
2. Male puparium.
3. Female puparium, from above.
4. ,, ,, from below.
5. ,, ,, with ventral scale removed.
6. Adult female, ventral view.
7. ,, ,, pygidium.